

AIR ATTACK ON AMERICA?: VULNERABILITIES, CAPABILITIES, AND
IMPLICATIONS OF THE AIR DEFENSE OF THE UNITED STATES

BY

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The undersigned certify that this thesis meets master's-level standards of research, argumentation, and expression.

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DISCLAIMER

The conclusions and opinions expressed in this document are those of the author. They do not reflect the official position of the US Government, Department of Defense, the United States Air Force, or Air University.

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ABSTRACT

The events of 9/11 highlighted the deteriorated state of the United States air defense system. Although some reorganization of the air defense system of the US occurred, as a whole, there is no continental integrated air defense system in place today. The purpose of this thesis is to examine the need for a continental integrated air defense system.

In order to accomplish the examination of the need for a continental air defense system, this thesis reviews two case studies. The first case study examines the creation of the British integrated air defense system in the interwar years and the second case study examines the creation of the United States integrated air defense system of the beginning of the Cold War. These case studies seek to determine the threat, country and weapon, which prompted the construction of an air defense system. Furthermore, these case studies seek to determine the validity of using public opinion as a litmus test for the creation of an air defense system. Finally, these case studies seek to determine commonalities in the systems and technology, rules of engagement, and command and control required for an integrated air defense system to be successful.

The examination concludes that the current air defense setup in the United States is adequate for the current threats. This does not mean that the United States can disregard its air defense system. Instead, the United States should continue to research, develop, and plan the capabilities to defend against the threats of today in order to be able to execute tomorrow because the cost of failure when the moment arises is unacceptable.

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Chapter 1

Introduction

By November 1918, the bomber had found acceptance in both Britain and America. In Britain it inspired lasting terror which left that nation determined to build a powerful strategic force and, even twenty years later, gave pause to Chamberlain at Munich. In America, it inspired casual fascination and easy hopes. For neither country was the test of war sufficient to challenge these reactions. As exploration of that middle ground between apocalyptic fantasy and careless dismissal, the war experience was too incomplete to confirm the Wellsian prophecy. Too much had happened in World War I for that generation to ignore the bomber, but too little had happened to appreciate fully its potential and limitations. Both extravagant hopes and unreasoning fears were still possible.

~ Michael S. Sherry

Fear of an attack from the air has been in the minds of citizens for over a century. Bombs falling on London in WWI produced a feeling of vulnerability in the average British civilian, who had enjoyed the security provided by the Royal Navy for centuries. This sense of vulnerability was the driving force in developing Britain's air defense system between WWI and WWII. This system provided a British victory over the Germans in the Battle of Britain. Later in that conflict, the devastation delivered by the United States bombings of Germany and Japan, crowned by dropping atomic bombs on Hiroshima and Nagasaki, proved the destructive capability of air power. The Soviet detonation of a nuclear bomb, shortly thereafter, created in the United States a similar feeling of vulnerability to attack from the air. This perceived vulnerability was the driving force in developing an air defense system in the 1950s and 60s. As the primary threat to the United States transitioned from Soviet nuclear laden bombers to Soviet nuclear intercontinental ballistic

missiles (ICBMs), the existing air defense system declined in significance.¹

The end of the Cold War, symbolized by the dismantling of the Berlin Wall in the fall of 1989, triggered almost a complete abandonment of the remaining United States' air defense capabilities. By early 1993, General Colin Powell, Chairman of the Joint Chiefs of Staff, declared that, due to the decreased Soviet threat, the United States no longer needed a significant dedicated air defense force. A year later, the General Accounting Office concurred with General Powell's recommendation and concluded that a dedicated air defense force was no longer needed.² As a result, on 11 September 2001, "the responsibility for defending the continental US airspace rested with only fourteen fighter aircraft at seven air defense alert sites across the country."³ This air defense force was only a shadow of the dedicated air defense force erected by the United States at the inception of the Cold War.

As Russia attempts to regain its Cold War power status, it has resumed bomber penetration of the United States' air defense identification zone (ADIZ) as well as announced resumption of submarine patrols off the coast of the United States.⁴ For example, on 12 February 2013, just hours before President Obama's state of the union address, two Russian nuclear-armed Tupelov Tu-95 Bear bombers circled the island of Guam, a United States territory in the western Pacific.⁵ John Bolton, the former United Nations ambassador and former State

¹ Center of Military History, *History of Strategic Air and Ballistic Missile Defense*, vol. 2, 1956-1972 (Washington, DC: United States Army, 2009), 13.

² Priscilla D. Jones, *The First 109 Minutes: 9/11 and the U.S. Air Force* (Washington, DC: Air Force History and Museums Program, 2011), 7-8.

³ Jones, *The First 109 Minutes*, 7.

⁴ Robert Tilford, "Russia Set to Increase Submarine Patrols to Counteract US Threat," *Examiner*, 25 February 2012, <http://www.examiner.com/article/russia-set-to-increase-submarine-patrols-to-counteract-us-threat> (accessed 24 October 2012).

⁵ Bill Gertz, "Russian Bombers Over Guam," *Fox News*, 19 February 2013, <http://nation.foxnews.com/russia/2013/02/19/russian-bombers-over-guam> (accessed 21 March 2013).

Department Undersecretary for International Security, said, “the Russian bomber flights appear to be part of an increasingly threatening strategic posture in response to Obama administration anti-nuclear policies.”⁶ These actions are forcing defense analysts to assess the risk to the United States and to consider what kind of air defense system is needed by the United States today. If the United States air defense capability meets the current need, when would the United States need to adapt its air defense system?

In order to assess the United States’ needs for an air defense system, a definition of an air defense system is required. The concept of defense from air attack has its foundations in air theory originating out of the First World War. The Italian air power theorist Giulio Douhet believed that the only defense against an attack from the air was to destroy the enemy’s air forces on the ground. “Because of its independence of surface limitations and its superior speed – superior to any other known means of transportation – the airplane is the offensive weapon par excellence. The greatest advantage of the offensive is having the initiative in planning operations – that is being able to choose the point of attack. Whereas the enemy, on the defensive and not knowing the direction of the attack, is compelled to spread his forces thinly to cover all possible points of attack along his line of defense.”⁷ More simply, Douhet stated, “Aerial warfare admits of no defense, only offense.”⁸ A Douhetian air defense system would focus on the ability to attack your enemy from the air before he attacks you.

In the 1920s, the American air power theorist Billy Mitchell’s first pitch to the American public for an independent air force focused on

⁶ Bill Gertz, “Russian Bombers Over Guam,” *Fox News*, 19 February 2013, <http://nation.foxnews.com/russia/2013/02/19/russian-bombers-over-guam> (accessed 21 March 2013).

⁷ Giulio Douhet, *The Command of the Air*, ed. Joseph Patrick Harahan and Richard H. Kohn (Tuscaloosa, AL: The University of Alabama Press, 2009), 16.

⁸ Douhet, *The Command of the Air*, 55.

protecting the United States from enemy air and naval attacks. Even in promoting the Air Force's role in the defense of the United States' homeland, Mitchell believed that air forces were inherently offensive and that the best defense was to take the initiative and attack first.⁹ However, "when seizing the initiative and carrying the air war into the enemy's country is not possible or practicable, the only other method of defense against aircraft is the use of guns and cannon from the ground, combined with the action of defensive pursuit aviation."¹⁰ Finally, if defense of a locality is required, Mitchell provided a list of requirements:

First, that there be a circle of listening and reporting posts, extending for at least a hundred and fifty miles out from the area to be defended. These should be supplemented by aerial observations posts and surveillance aircraft. Second, there should be an organization of pursuit aircraft, the type that rises rapidly and maneuvers easily. Third, there should be several circles of searchlights in groups of forty or fifty each... Fourth, there should be anti-aircraft guns and cannon. All of these elements should be under one control, that of the air commander or the one charged with the whole of the air defense of the locality.¹¹

Mitchell's early concept of air defense provided the foundation for developing the modern concept of air defense.

First, Mitchell's claim of the offensive nature of air power and an air defense's need for a strong offensive capability has been maintained in the Air Force ethos through the present day. AWPD-1, the Army Air Force plan for World War II, called for production of bombers in large numbers while only calling for pursuit aircraft in limited numbers. Pursuit aircraft, in the minds of the planners, were for defense of bases

⁹ William "Billy" Mitchell, *Winged Defense* (Tuscaloosa, AL: The University of Alabama Press, 2009), 109.

¹⁰ Mitchell, *Winged Defense*, 203.

¹¹ Mitchell, *Winged Defense*, 209-210.

and areas of vital interest, because the bombers would achieve command of the air by destroying enemy aircraft on the ground.¹²

In the 1950s, weapons design and procurement was based on the primary assumption that the “[bomber] always gets through.”¹³ A little more than a decade later, as the primary threat to the security of the United States shifted from Soviet nuclear bombers to Soviet ICBMs, the strategy of mutually assured destruction effectively removed the need for a United States continental air defense by the mid-1960s.¹⁴ Mutually assured destruction operated under the premise that the offense was so strong, no enemy would risk complete destruction by attacking. Deterrence theory became dominant in the halls of the Pentagon. Bernard Brodie in *Strategy in the Missile Age* provides the key propositions to deterrence as dictated by the overwhelming destructive power of nuclear weapons. The purpose of deterrence is to convince the enemy not to act because the cost of aggression is higher than the potential benefits. In order for deterrence to work, the enemy must first believe that the threat is credible. Second, given that the United States will not strike first, that the capability to retaliate is guaranteed.¹⁵ Finally, “Stability is achieved when each nation believes that the strategic advantage of striking first is overshadowed by the tremendous cost of doing so.”¹⁶ As a result of the increased reliance of the United States on deterrence, the steady decline in the air defense capability of the United States between the mid-1960s and early-1990s occurred at approximately

¹² Robert Frank Futrell, *Ideas, Concepts, Doctrine*, vol. 1, *Basic Thinking in the United States Air Force 1907-1960* (Maxwell Air Force Base, AL: Air University Press, 1989), 110.

¹³ Ernest J. Yanarella, *The Missile Defense Controversy: Technology in Search of a Mission* (Lexington, KY: The University Press of Kentucky, 2002), 76.

¹⁴ Center of Military History, *History of Strategic Air and Ballistic Missile Defense*, vol. 2, 1956-1972, 13.

¹⁵ Bernard Brodie, *Strategy in the Missile Age* (1959; repr., Santa Monica, CA: RAND, 2007), 268-303.

¹⁶ Brodie, *Strategy in the Missile Age*, 303.

the same rate the relative offensive capability of the United States increased over its closest rivals.

Second, Mitchell's list of requirements for the defense of a locality still apply to modern needs. Joint Publication 3-01 defines an integrated air defense system (IADS) as "the aggregate of component air defense systems operating in a theater or specific area of operations. The joint term IADS encompasses the Service-specific air and missile defense (AMD) missions of the Army, Marine Corps, and Navy, with the Air Force's counterair mission. An IADS is comprised of the personnel, sensors, weapons, equipment, and intelligence systems to command and control (C2) an air defense (AD) system."¹⁷ Mitchell's list of requirements closely mirrors this definition. Mitchell's air and missile defense weapons consisted of a combination of pursuit aircraft and anti-aircraft guns and cannons. Mitchell's sensors included listening and reporting posts, aerial observations posts and surveillance aircraft, and searchlights. Finally, Mitchell's command and control consisted of a single air commander charged with the whole of air defense of a specific location.¹⁸

Just because the American definition of an IADS appears to have remained relatively constant since the days of Mitchell does not mean that the United States employs a system commensurate with that definition. The purpose of this endeavor, therefore, is to determine whether the United States requires a continental integrated air defense system. Working towards that objective, the purpose of chapter two is to explore the current Air Defense system of the United States and determine where it sits in comparison to the doctrinal definition. Chapter three provides a case study of the British Air Defense System built in the years between World War I and World War II. Chapter four

¹⁷ Joint Publication (JP) 3-01, *Countering Air and Missile Threats*, 23 March 2012, 1.

¹⁸ Mitchell, *Winged Defense*, 209-210.

provides a case study of the United States Air Defense System built immediately following World War II. Investigating these examples attempts to answer several key questions. First, why did the nation build an integrated air defense system? Second, what was the perceived threat? Third, what was public opinion concerning the perceived threat? Fourth, what systems/technology did the nation put in place to detect and act upon that threat? Fifth, what was the system for command and control? Sixth, what were the rules of engagement (ROE) for acting upon the threat? Seventh, what did this air defense system provide for future military capability? Finally, when put to the test, how did the integrated air defense system perform? After careful scrutiny of the data, chapter five attempts to build a general framework for an air defense system, based on classical theory and drawing on the historical examples provided in the two case studies. It also, and most importantly, attempts to answer whether the United States should build an IADS today, and, if not, what conditions should exist to signal future decision makers that it is time to build an IADS.

Chapter 2

Current United States Air Defense Capability

Never in history have American fighters been faced with having to fly a combat air patrol over an American city, in skies filled with hundreds of airliners.

~ Lynn Spencer

The events of 9/11 triggered a complete reevaluation of the American stance on air defense in the United States. As late as 1993, General Powell, the Chairman of the Joint Chiefs of Staff (CJCS), recommended, “the United States no longer needed a large, dedicated air defense force” because of the reduced threat from the Soviet Union.¹ Yet on the morning of 11 September 2001, the air defense posture of the United States was found lacking. Although the purpose of this chapter is not to dwell on the specifics of 9/11, the events of that morning drove the organization, responsibilities, and capabilities of the current air defense structure of the United States. Ultimately, the term homeland defense ceased to be jargon and became part of the common US vocabulary.

Homeland Defense is the term the United States utilizes to define all aspects of the protection of the “sovereignty, territory, domestic population, and critical defense infrastructure against external threats and aggression, or other threats as directed by the President.”² Joint Publication 3-27 defines eight objectives the Department of Defense (DOD) must pursue in order to succeed in homeland defense:

1. Identify the threat.
2. Dissuade adversaries from undertaking programs or conducting actions that could pose a threat to the US homeland.

¹ Jones, *The First 109 Minutes*, 7.

² Joint Publication (JP) 3-27, *Homeland Defense*, 12 July 2007, vii.

3. Ensure defense of the homeland and deny an adversary's access to the nation's sovereign airspace, territory, and territorial seas.
4. Ensure access to space and information.
5. Protect defense critical infrastructure (DCI).
6. Deter aggression and coercion by conducting global operations.
7. Decisively defeat any adversary if deterrence fails.
8. Recover from any attack or incident.³

These diverse objectives show that air defense is a key piece of the homeland defense problem. Joint Publication 3-27 goes on to define air defense and aerospace defense. Air defense is defined as “defensive measures designed to destroy attacking enemy aircraft or missiles in the atmosphere, or to nullify or reduce the effectiveness of such attack.”⁴ Aerospace defense, on the other hand, “includes air defense, ballistic missile defense and the defense of US space assets.”⁵ This chapter specifically addresses the current capability of the United States air defense and ballistic missile defense systems and is hereafter collectively referred to as air defense.

Air defense capability is currently designed to meet the DOD charge of defeating air threats to the United States. These air threats are both traditional and non-traditional. Traditional threats categorically describe attacks from military aircraft, cruise missiles, and ballistic missiles.⁶ Nontraditional threats include “commercial or chartered aircraft, general aviation, ultralight aerial vehicles, unmanned aerial vehicles, radio controlled aircraft or even balloons.”⁷ However, when

³ JP 3-27, *Homeland Defense*, viii.

⁴ JP 3-27, *Homeland Defense*, III-1.

⁵ JP 3-27, *Homeland Defense*, III-1.

⁶ JP 3-27, *Homeland Defense*, III-1.

⁷ JP 3-27, *Homeland Defense*, III-1.

discussing capabilities, this chapter splits these threats into air-breathing threats and non-air-breathing threats. Air-breathing threats include military aircraft, cruise missiles, and the nontraditional air threats listed above, whereas the non-air-breathing threat refers to the ballistic missile threat.

The responsibility for defending the United States against air-breathing and non-air-breathing threats lies with US Northern Command (USNORTHCOM) and North American Aerospace Defense Command (NORAD). NORAD is primarily responsible for aerospace warning and control, while USNORTHCOM is primarily responsible for conducting military operations using force “to deter, detect, or defeat an incursion into sovereign territory.”⁸ USNORTHCOM protects sovereign airspace from air-breathing threats via Operation Noble Eagle (ONE). “Operation Noble Eagle is the overall umbrella operation covering [homeland defense] for North America.”⁹ Furthermore, NORAD is tasked with supplying forces and command and control to the ONE mission.¹⁰ USNORTHCOM is also responsible for planning and executing ballistic missile defense to handle the non-air-breathing threat to North America.¹¹

Air-Breathing Threat

Operation Noble Eagle found its birth in the aftermath of 9/11 and was specifically created to ensure a repeat of 9/11 never occurred. The Air National Guard handles approximately 82% of this air defense mission.¹² The Army and Navy help fulfill the remainder of ONE’s responsibilities. One such mission is Task Force Phoenix. Task Force

⁸ JP 3-27, *Homeland Defense*, II-2.

⁹ JP 3-27, *Homeland Defense*, xii.

¹⁰ JP 3-27, *Homeland Defense*, xii.

¹¹ JP 3-27, *Homeland Defense*, xv.

¹² Otto Kreisher, “The Years of Noble Eagle,” *Air Force Magazine* 90, no. 6 (June 2007), <http://www.airforce-magazine.com/MagazineArchive/Pages/2007/June%202007/0607eagle.aspx> (accessed 31 December 2012).

Phoenix, filled by an Army air defense artillery unit, is “one of the largest missions under Operation Noble Eagle and [is] charged with defending 2,500 square miles of air space over the District of Columbia and its surrounding communities.”¹³ The air defense artillery unit defends the airspace with standard Army air defense artillery equipment, including short-range missiles such as Avengers and MANDPADS, and radar.¹⁴

ONE includes active and passive measures. Bernard Brodie in *Strategy in the Missile Age* states “Defense against hostile weapons in all forms of warfare...has always basically consisted of a combination of two things: first, measures to reduce the number of enemy weapons dropped or thrown or to spoil their aim by hitting the enemy as he attacks (i.e. *active defenses*); and second, preparations to absorb those weapons that actually strike home (i.e. *passive defenses*).”¹⁵ This chapter concentrates on the active defenses, or more specifically, the equipment used by the Army and Air Force in stopping an attack on the United States. Army equipment designed to defend against the air-breathing threat includes short-range anti-aircraft missiles, Avengers, and long-range anti-aircraft missiles, Patriots, in conjunction with applicable sensors. Air Force equipment includes F-16, F-15C, and F-22 fighter aircraft with applicable on and off-board sensors.

F-16, F-15C, and F-22 aircraft perform two roles in support of ONE. The first is ONE Air Sovereignty Alert and the second is ONE Combat Air Patrols (CAPs). Since 2001, these aircraft have flown over 55,000 sorties and over 2,350 scrambles, quick launches of a fighter for the sole purpose of responding to an alert, in support of Air Sovereignty Alert. CAPs are also flown in support of special security events such as

¹³ Mike Smith, “Guard Air Defense Units Protect Nation’s Capital,” *Army News Service*, 22 April 2010, <http://www.globalsecurity.org/security/library/news/2010/04/sec-100422-arnews01.htm> (accessed 31 December 2012).

¹⁴ Smith, “Guard Air Defense Units Protect Nation’s Capital.”

¹⁵ Bernard Brodie, *Strategy in the Missile Age* (1959; repr., Santa Monica, CA: RAND, 2007), 180.

the Super Bowl, presidential inaugurations, state funerals, United Nations General Assemblies, and the State of the Union Address.¹⁶ CAPs are more localized air defense. However, Air Sovereignty Alerts provide the basis of United States air defense due to the speed and range of fighter aircraft.

Army air defense artillery units, on the other hand, are not numerous enough to provide coverage for the entire country. These units must either be part of an existing system, such as the National Capital Region – Integrated Air Defense System (NCR-IADS), or be pre-staged in preparation of special events needing additional air defense protection measures. The primary equipment in an Army Air Defense unit consists of Avenger and Patriot. The Avenger is a “line-of-sight, mobile, shoot-on-the-move, short-range air defense system.”¹⁷ This system uses guided and unguided rockets, guns, and high-energy laser and allows multiple configurations. The Patriot “‘hit-to-kill’ PAC-3 Missile is the world’s most advanced, capable, and powerful terminal air defense missile. It defeats the entire threat: tactical ballistic missiles (TBMs), cruise missiles, and aircraft.”¹⁸ Neither of these systems is effective beyond the immediate protection of a specific location. For example, Avenger is effective out to five miles and up to 10,000 feet.¹⁹ Patriot, on the other hand, is effective out to 25 miles.²⁰

¹⁶ CONR-1AF (AFNORTH), “CONR Achieves 55,000th Noble Eagle Sortie,” *1st Air Force*, 14 January 2010, <http://www.1af.acc.af.mil/news/story.asp?id=123185605> (accessed 2 January 2013).

¹⁷ Boeing, “Avenger Derivatives: Adaptive Force Protection Solutions,” *Boeing*, March 2012, http://www.boeing.com/defense-space/space/avenger/docs/Avenger_overview.pdf (accessed 2 Jan 2013).

¹⁸ Lockheed Martin, “PAC-3 Missile,” *Lockheed Martin*, <http://www.lockheedmartin.com/us/products/PAC-3.html> (accessed 2 Jan 2013).

¹⁹ John Pike, “FIM-92A Stinger Weapons System: RMP & Basic,” *Federation of American Scientists*, 9 August 2000, <http://www.fas.org/man/dod-101/sys/land/stinger.htm> (accessed 22 March 2013).

²⁰ Missile Threat, “Patriot,” *Missile Threat*, 23 April 2013, <http://missilethreat.com/defense-systems/patriot/> (accessed 24 April 2013).

ONE is a collection of capabilities to perform homeland defense and cannot be considered an IADS. An IADS, according to Joint Publication 3-01, is “the aggregate of component air defense systems operating in a theater or specific area of operations. The joint term IADS encompasses the Service-specific air and missile defense missions of the Army, Marine Corps, and Navy, with the Air Force’s counterair mission. An IADS is comprised of the personnel, sensors, weapons, equipment, and intelligence systems to command and control an air defense system.”²¹ ONE does include an aggregate of component air defense systems operating within the continental US encompassing multiple Services and is comprised of personnel, sensors, weapons, equipment, and intelligence systems. However, the component air defense systems and applicable personnel, sensors, weapons, equipment, and intelligence systems are not integrated into a single command and control system, thereby denying ONE IADS status.

The National Capital Region (NCR), on the other hand, is a functioning IADS. “The National Capital Region is the political and military center of gravity of the U.S. with an infrastructure vital to the global interests of the nation.”²² “The NCR-IADS augments the ONE fighter defenses by providing “assets in-place” in a quick reaction posture to protect the seat of the US government, as well as other key locations in the NCR, from air attacks.”²³ The NCR-IADS ties together Federal Aviation Administration (FAA) radars, military radars, video cameras, visual warning systems, fixed and rotary wing intercept aircraft, and short and medium-range missile systems.²⁴ This collection of

²¹ Joint Publication (JP) 3-01, *Countering Air and Missile Threats*, 23 March 2012, 1.

²² U.S. Northern Command, “About USNORTHCOM,” *U.S. Northern Command*, <http://www.northcom.mil/About/index.html> (accessed 1 Jan 2013).

²³ JP 3-27, *Homeland Defense*, III-4.

²⁴ JP 3-27, *Homeland Defense*, III-5.

capabilities fused into a single air defense system is what makes it the only active IADS in the country.

Although the National Capital Region has not come under direct attack, the NCR-IADS is tested by an occasional errant small airplane on a fairly regular basis. ON 11 May 2005, a Cessna 150 wandered into the NCR-IADS restricted airspace. In response, F-16s from Andrews Air Force Base were scrambled to intercept the Cessna and escort it out of the restricted airspace. The Cessna was intercepted and diverted by the F-16s before it would have had the ability to do any damage to the White House if the aircraft had hostile intentions.²⁵ Again, on 24 April 2009, a small, single-engine plane penetrated the NCR-IADS restricted airspace and again the plane was successfully intercepted and diverted, before it would have had the ability to do any damage to the White House.²⁶ According to the Washington Times in April 2009, FAA figures show that since 2001, “aircraft have entered restricted airspace around the nation’s capital roughly twice a day.”²⁷ Despite the frequency by which small aircraft test the NCR-IADS, no glitches in the air defense system have been noted.

Non-Air-Breathing Threat

Protection against the ballistic missile threat is completely different from the air-breathing threat. The organization responsible for the development of anti-ballistic missile (ABM) technology is outside the purview of the individual services. The threat is limited to ballistic

²⁵ Spencer S. Hsu and John Mintz, “Military was Set to Down Cessna,” *The Washington Post*, 25 May 2005, <http://www.washingtonpost.com/wp-dyn/content/article/2005/05/24/AR2005052400408.html> (accessed 21 March 2013).

²⁶ The Washington Times, “Errant Cessna Cues White House Lockdown,” *The Washington Times*, 25 April 2009, <http://www.washingtontimes.com/news/2009/apr/25/errant-cessna-cues-white-house-lockdown/?page=all> (accessed 21 March 2013).

²⁷ The Washington Times, “Errant Cessna Cues White House Lockdown,” *The Washington Times*, 25 April 2009, <http://www.washingtontimes.com/news/2009/apr/25/errant-cessna-cues-white-house-lockdown/?page=all> (accessed 21 March 2013).

missiles, and, although active and passive defenses are also used, the active defense technology has very little overlap to the equipment used against the air-breathing threat.

The organization responsible for developing, testing, and fielding a defense against ballistic missiles is the Missile Defense Agency (MDA). The MDA falls under the Department of Defense and was created by the National Missile Defense Act of 1999.²⁸ Whereas, the individual services are responsible for developing their own capability against the air-breathing threat, this separate agency within the DOD is responsible, outside the individual services purview, for defense against ballistic missiles. However, just as with the air-breathing threat, USNORTHCOM is still “responsible for planning and executing ballistic missile defense” of North America.²⁹

The ballistic missile threat includes short, medium, intermediate and long-range ballistic missiles. The goal of ballistic missile defense is to “build a layered, integrated capability to defeat inbound missiles in all phases of flight and...includes the synchronization and integration of capabilities to destroy or disrupt adversary missiles in flight or prior to launch.”³⁰ Intercontinental ballistic missiles (ICBMs) have the longest range and therefore dictate the requirements for the technology to defeat all forms of ballistic missiles.

The Ballistic Missile Defense System (BMDS), as envisioned by the MDA, includes the ability to detect, track, and engage missiles in the boost and ascent, midcourse, and terminal phases of missile flight. Current active measures are in development for all three phases. The Aegis Ballistic Missile Defense (BMD) Standard Missile-3 is designed to counter the threat in the boost and ascent phase. Ground-based

²⁸ Missile Defense Agency, “Our Mission,” *Missile Defense Agency*, <http://www.mda.mil/about/mission.html> (accessed 2 Jan 2013).

²⁹ JP 3-27, *Homeland Defense*, xv.

³⁰ JP 3-27, *Homeland Defense*, xv.

Midcourse Defense (GMD) system is designed to counter the threat in the midcourse phase. Finally, Terminal High Altitude Area Defense (THAAD) and Patriot PAC-3 are designed to counter the threat in the terminal phase of flight. These systems are paired with a multitude of sensors to provide the detection and tracking of the missiles and include space-based sensors, forward radars, sea-based X-Band radar, and Aegis BMD SPY-1 radars.³¹

Aegis BMD, GMD, THAAD, and Patriot PAC-3 all utilize a hit-to-kill method of destroying the missile. Development of the integrated system began in 2001. Between 2001 and October 2012, the overall test record had a success rate of 56 of 77 hit-to-kill intercepts or 79 percent. The weakest link in the system was GMD with only 8 of 15 (53 percent) successful hit-to-kill intercepts since 1999. Aegis BMD had a 79 percent success rate and THAAD had performed superbly with a 100 percent success rate since testing began in 2006.³²

Wrap-Up

The United States enjoys a position of superior air defense technological capability. Army systems such as GMD, THAAD, and Patriot PAC-3 and Air Force systems such as F-15Cs, F-16s, and F-22s are highly capable technological achievements. However, the geographic size of the United States and the small numbers of those systems limits the ability of USNORTHCOM to defend all United States territory simultaneously and with equal ferocity. USNORTHCOM can use these capabilities with proper intelligence and warning to defend the homeland with some flexibility. The truth is that poor intelligence and late warning could thwart command and control of air defenses, which is the reason

³¹ Missile Defense Agency, "The Ballistic Missile Defense System (BMDS)," *Missile Defense Agency*, <http://www.mda.mil/system/system.html> (accessed 2 Jan 2013).

³² Missile Defense Agency, "Missile Defense Agency Fact Sheet: Ballistic Missile Defense Intercept Flight Test Record," *Missile Defense Agency*, 26 October 2012, <http://www.mda.mil/global/documents/pdf/testrecord.pdf> (accessed 2 Jan 2013).

for an actual IADS in the National Capital Region. No other single geographic point in the United States has the density of critical infrastructure and decision-making to justify the cost of dedicated assets. No other IADS exists in the United States.

Chapter 3

Case Study 1: Britain's Creation of an Air Defense System in the Interwar Years

A combination of Wellsian air power destructiveness and Britain's claim to being the first to have its civilians bombed from the air in World War I resulted in a strong desire to defend Britain from air attack. However, along with the drawdown of forces following the First World War, the drive to develop a stronger air defense also declined. With first a threat of French air power and then the creation of the Luftwaffe, the German Air Force, the drive to develop a robust air defense capability again found traction in Britain. Technological advances in aircraft design, wireless telephone, and radar all came together to provide the needed air defense capability required to defeat a German air attack in what would be called the Battle of Britain.

This case study attempts to answer several questions. First, why did Britain build an integrated air defense system in the interwar years? Second, what was the perceived threat? Third, what was public opinion concerning the perceived threat? Fourth, what systems/technology did Britain put in place to detect and act upon that threat? Fifth, what was the system for command and control? Sixth, what were the rules of engagement (ROE) for acting upon the threat? Seventh, what did this air defense system provide for future military capability? Finally, how did the system work?

Why did the Britain build an integrated air defense system in the interwar years?

Unlike its neighbors on the continent, as an island, Britain enjoyed a geographic advantage made secure by the Royal Navy's command of the sea. British control of the expanse of water separating the island nation from its neighbors on the European continent made attacking Britain extremely difficult. As a result, the last successful invasion of

Britain occurred in 1066. However, the advent of aerial bombardment in 1911 would soon undermine the perceived invulnerability of the British Isles.¹

Britain was more vulnerable to attack from the air than its neighbors on the continent. The same geographic advantage that made it more secure than its neighbors on the continent in the sea power age now became a disadvantage in the air power age. The English Channel and the North Sea made visually acquiring Britain from the air extremely easy. These large features were easy for pilots to find visually and once acquired, easily funneled pilot's eyes to Britain. Furthermore, the River Thames acted like an arrow pointing right at the heart of London.² To make matters worse, the unusual concentration of London's industrial and urban areas combined with London's close proximity to the east coast of Britain put it within easy striking range from airfields in France and the Low Countries.³

The first air attack on Britain resulted in little damage and no loss of life. On Christmas Eve, 1914, "a German seaplane dropped a bomb that exploded in a garden near Dover on the Kent coast."⁴ Then, in January 1915, under the cover of darkness, German airship raids began. Airships were developed to counter the inability of the early airplanes to cover long distances or carry heavy payloads and were therefore used extensively in World War I by the Germans to attack Britain. Once again, damage and casualties were limited.⁵ However, the possibility for

¹ Eyder Peralta, "100 Years Ago, World's First Aerial Bomb Dropped Over Libya," *NPR*, 21 March 2011, <http://www.npr.org/blogs/thetwo-way/2011/03/21/134735395/100-years-ago-the-first-aerial-bomb-fell-over-libya> (accessed 17 February 2013).

² Malcolm Smith, *British Air Strategy Between the Wars* (New York, NY: Oxford University Press, 1984), 109.

³ M. Kirby and R. Capey, "The Air Defence of Great Britain, 1920-1940: An Operational Research Perspective," *The Journal of the Operational Research Society* 48, no. 6 (June 1997): 557.

⁴ Vincent Orange, *Dowding of Fighter Command: Victor of the Battle of Britain* (London, England: Grub Street Publishing, 2008), 52.

⁵ Vincent Orange, *Dowding of Fighter Command*, 53.

greater damage and higher casualties became real when bombs fell on King's Lynn in Norfolk on the night of 19 January 1915.⁶ The populace of King's Lynn became the first civilians ever to be attacked from the air.⁷ On 8 September 1915, the Germans bombed London for the first time. These first bombings of Britain were conducted by German Zeppelin airships. However, the Germans also began to use bombers to attack British cities. For example, "on 28 November 1916, a lone German bomber dropped six small bombs on London and made off unharmed."⁸ Again, in June 1917, German Gotha bombers attacked London in broad daylight with greater results; 162 people were killed and another 432 injured and all but 11 of the casualties were civilians. Included in the casualties were 46 school children.⁹

The Royal Flying Corps struggled to defend against these attacks and did not down their first Zeppelin until the night of 2 September 1916.¹⁰ The inherently offensive nature of airpower at the time made defending against attack from the air difficult. Defending aircraft required significant time to climb to altitude and, once at altitude, relied on searchlights or moon illumination to point out enemy airships. These difficulties, combined with the lack of night flying instrumentation for both aircraft and airfields, made attempting an intercept difficult and successfully downing an airship almost impossible.¹¹ This point is evident by the imbalance between British defensive resources and their success rate. "At the end of the war the British were employing 200 fighters and 450 guns in home defense."¹² Of the approximately sixty

⁶ Stephen Bungay, *The Most Dangerous Enemy: A History of the Battle of Britain* (London, England: Aurum Press, 2000), 55.

⁷ Bungay, *The Most Dangerous Enemy*, 55.

⁸ Bungay, *The Most Dangerous Enemy*, 55.

⁹ Kirby and Capey, "The Air Defence of Great Britain," 556.

¹⁰ Bungay, *The Most Dangerous Enemy*, 55.

¹¹ Geoffrey Norris, *The Royal Flying Corps: A History* (London, England: Frederick Muller Limited, 1965), 89-91.

¹² Bungay, *The Most Dangerous Enemy*, 55.

German bomber losses during the Britain campaign, only about twenty were a result of the British air defenses. The remaining forty losses were a result of accidents, not successful British air defense.¹³ The conclusion of World War I also brought a temporary suspension to worrying about the air defense of Britain.

Worsening relations with France in 1921 again forced the issue of the air defense of Britain.¹⁴ By this time the British air forces were under a separate service: the Royal Air Force (RAF). In March, the Air Ministry informed the Committee for the Imperial Defense (CID) that “the primary function of the Air Force in the future would be the defense of the British Isles from invasion by air from the continent Europe. This defense would largely take the form of a counter-offensive from the air assisted by a ground organization coordinated by the Air Ministry.”¹⁵ The CID agreed and gave the RAF the primary role in defense of the United Kingdom in mid 1921.¹⁶

Preparations for the Washington Conference to be held in November 1921 revealed that French air strength was much greater than British air strength. British suspicion that the French would use their superior air strength as a negotiating tool to gain international concessions over the British made this gap dangerous and therefore required action to mitigate the French air threat.¹⁷ Arthur Balfour, a member of the Cabinet, in response to the air strength gap, told CID, “since the RAF was too weak to withstand a French aerial invasion,

¹³ Bungay, *The Most Dangerous Enemy*, 55.

¹⁴ John Ferris, “Fighter Defence Before Fighter Command: The Rise of Strategic Air Defence in Great Britain, 1917-1934,” *The Journal of Military History* 63, no. 4 (October 1999): 855.

¹⁵ Neil Young, “British Home Air Defence Planning in the 1920s,” *Journal of Strategic Studies* 11, no. 4 (1988): 494.

¹⁶ John Ferris, “The Theory of a ‘French Air Menace’, Anglo-French Relations and the British Home Defence Air Force Programmes of 1921-25,” *Journal of Strategic Studies* 10, no. 1 (1987): 64.

¹⁷ Young, “British Home Air Defence Planning in the 1920s,” 492.

Britain was more defenseless than it has ever been before.”¹⁸ In response, the Air Council in July 1922 finally responded with the plan for defense of Britain. The RAF would have the capability to provide a knockout blow to an enemy rendering him incapable of mounting an attack.¹⁹ However, the Air Council also acknowledged the need to have some form of defensive system at home, because no air force could guarantee freedom from air attack while executing a purely offensive campaign.²⁰

In response to the need to have a home defensive air system, Britain set up a committee in 1923 with the purpose of developing a plan to defend British airspace from an attack originating across the Channel.²¹ The outcome of the air defense committee was the formation of the Air Defense of Great Britain (ADGB) on 1 January 1925.²² As a result, all home based fighters and bombers fell under ADGB.²³ Just as an air defense organization was born, however, the British and French signed the Treaty of Locarno on 1 December 1925. The treaty committed Britain to guarantee the security of France, and, as a result, Britain no longer viewed the French Air Force as a threat.²⁴ With no valid threat, there was also no drive for rearmament. The existing force remained mostly unchanged, although planning continued, until Germany became a legitimate threat in the early-1930s.

Then in 1933, Hitler assumed the Chancellorship of Germany.²⁵ Shortly thereafter, on 15 March 1934, Germany rejected Part V of the Treaty of Versailles, introduced military conscription, and the very next

¹⁸ Ferris, “The Theory of a ‘French Air Menace’,” 65.

¹⁹ Young, “British Home Air Defence Planning in the 1920s,” 495-496.

²⁰ Young, “British Home Air Defence Planning in the 1920s,” 495-496.

²¹ Bungay, *The Most Dangerous Enemy*, 57.

²² Young, “British Home Air Defence Planning in the 1920s,” 499.

²³ Young, “British Home Air Defence Planning in the 1920s,” 499.

²⁴ Young, “British Home Air Defence Planning in the 1920s,” 499.

²⁵ Smith, *British Air Strategy Between the Wars*, 311.

day announced the formation of the Luftwaffe.²⁶ The Member of Parliament for Epping, Winston Churchill, began voicing serious concern about German air strength.²⁷ As a result, Parliament eventually voted for a five-year general expansion plan for the RAF. This expansion plan resulted in the reorganization of the Royal Air Force into Bomber, Fighter, Coastal, and Training Commands in 1936, putting into place the structure that facilitated an air defense system that would eventually defeat the Germans in the Battle of Britain.²⁸

In 1934, however, the equipment and technology necessary for the eventual success in the Battle of Britain did not exist. The best defense at the time was still an offense capable of delivering a knockout blow to the enemy. This was known as deterrence through parity in air strike capability.²⁹ Yet a review of British air programs designed to reduce total costs by Sir Thomas Inskip, Minister for the Co-Ordination of Defense, in late November 1937 determined that the current RAF strategy of a knockout blow was incorrect. Inskip claimed that Britain was not capable of a delivering a knockout blow to Germany and should therefore concentrate its efforts on defense.³⁰ Inskip's determination meant that the RAF should ensure the safety of Britain before attempting to destroy the enemy with a knockout blow.³¹ In order to accomplish this, the RAF would need "a system of pure defense against air attack to secure the home country as a base for later offensive power."³² What Inskip highlighted was that the parity policy had failed to provide the diplomatic

²⁶ Smith, *British Air Strategy Between the Wars*, 149.

²⁷ Winston S. Churchill, *The Gathering Storm* (Boston, MA: Houghton Mifflin Company, 1948), 105. Also in Bungay, *The Most Dangerous Enemy*, 58.

²⁸ Bungay, *The Most Dangerous Enemy*, 58.

²⁹ Scot Robertson, *The Development of RAF Strategic Bombing Doctrine, 1919-1939* (Westport, CT: Greenwood Publishing Group, 1995), 146. Also in Smith, *British Air Strategy Between the Wars*, 80.

³⁰ Frank McDonough, *Neville Chamberlain, Appeasement and the British Road to War* (New York, NY: Manchester University Press, 1998), 41.

³¹ McDonough, *Neville Chamberlain, Appeasement and the British Road to War*, 41.

³² Smith, *British Air Strategy Between the Wars*, 183.

breakthrough, and, therefore, Britain needed some other form of deterring German aggression. Deterrence needed to switch from that of a knockout blow to that of the threat of a long war with Britain should Germany choose to attack.³³

Luftwaffe actions in the Spanish Civil War, operating as the Condor Legion, further reinforced the prevailing view of the destructive nature of air power and the vulnerability of a nation without an air defense system. The bombing of Guernica on 26 April 1937 delivered such devastation that it shocked the international community. “Whole families were buried in the ruins of their houses... cattle and sheep, blazing with white phosphorous, ran crazily between the burning buildings until they died. Blackened humans staggered blindly through the flames, smoke and dust, while others scrabbled in the rubble, hoping to dig out friends and relatives.”³⁴ According to the Basque government, casualties included 1,654 killed and 889 wounded. The Condor Legion bombed many other towns in Spain including Teruel in the Guadalajara region.³⁵ Reports of the indiscriminate killing of civilians from air attack continually made it back to Britain.

In short, Britain decided to build an integrated air defense system in the late 1930s because that was the only viable cost effective decision left that had the possibility of deterring German aggression. The German bombing of Britain in World War I impelled the British to ensure it did not happen again. One initial reaction was to seek an international agreement to abolish using the airplane as a weapon of war. While British politicians worked towards this goal, the Royal Air Force sought to deter any future aggression against Britain from the air via a credible

³³ Smith, *British Air Strategy Between the Wars*, 197.

³⁴ Antony Beevor, *The Battle for Spain: The Spanish Civil War 1936-1939* (New York, NY: Penguin Group, 1982), 232.

³⁵ Robert Stradling, *Your Children Will Be Next: Bombing and Propaganda in the Spanish Civil War 1936-1939* (Brigantine Place, Cardiff: University of Wales Press, 2008), 68.

deterrent from a large bomber force capable of providing a knockout blow. Attempts to abolish the airplane as a weapon of war via international agreement failed. After the creation of the Luftwaffe was announced, Britain realized that Germany was well ahead in aircraft production. The only viable option, then, was to deter German aggression with the threat of a long war. The only way to threaten a long war was to have a strong defense and in order to provide a strong defense Britain needed to develop better fighter aircraft and aircraft detection technology.³⁶ For the British, Germany's commanding air power lead posed a clear threat to their national security.

What was the perceived threat?

In the early 1920s as relations between Great Britain and France became strained, Britain viewed France, their former ally, as a threat. However, after Locarno, in the 1930s, Germany's rearmament and resurgent nationalism showed it was clearly willing to threaten its neighbors.

Preparations for the Washington Conference to be held in November 1921 revealed that French air strength was much greater than British air strength. British suspicion of French international aims made this gap dangerous and therefore required action to mitigate the French air threat.³⁷ It was not that Britain really thought France would attack, "Instead, its concern was with the diplomatic possibilities of France's strategic position: that is, with the question of whether France could further its foreign policy at Britain's expense by blackmailing Britain through the threat, explicit or otherwise, of French armed forces."³⁸ Britain should thus rearm to meet the potential of the French or offer a security commitment to France. A security commitment would provide France with the ability to reduce the size of its military resulting in parity

³⁶ Smith, *British Air Strategy Between the Wars*, 311.

³⁷ Young, "British Home Air Defence Planning in the 1920s," 492.

³⁸ Ferris, "The Theory of a 'French Air Menace'," 66.

with the British and thereby eliminate the perceived French threat. However, France allowed no diplomatic inroads into a security arrangement, and Britain therefore began its Home Defense Air Force (HDAF) program between 1922 and 1924.³⁹ By 1924, Britain had 98 HDAF aircraft and 132 on the way, to counter the French Air Force's 308 bombers.⁴⁰ The assets built under the HDAF program were then given to the Air Defense of Great Britain (ADGB), an organization formed in 1925, to manage the defense of Great Britain from air attack.⁴¹ However, with the signing of the Treaty of Locarno on 1 December 1925 the Cabinet no longer viewed France as a threat and calculated it would not be for at least another decade.⁴² Therefore, the completion date for the HDAF program was deferred from 1929 to 1935.⁴³

Hitler's accession to the German Chancellorship in 1933 quickly led to a deterioration in the international political situation. Evidence of Germany's preparations for an air force was clear. The significance of a German air threat did not go unnoticed by military planners in Britain. The entire British Isles were within 17 minutes flying time from fields in Belgium and the French northeast coast. This would be a serious concern if the Germans were ever to occupy those territories.⁴⁴ Therefore, on 16 November 1933, a recommendation of the CID to form a Defense Requirements Committee (DRC) was formally approved. The committee was composed of the three Chiefs of Staff, Sir Robert Vansittart of the Foreign Office, Sir Warren Fisher of the Treasury, and with Sir Maurice Hankey as Chairman.⁴⁵ Upon examination of the

³⁹ Ferris, "The Theory of a 'French Air Menace'," 67.

⁴⁰ Ferris, "The Theory of a 'French Air Menace'," 72.

⁴¹ Young, "British Home Air Defence Planning in the 1920s," 499.

⁴² Ferris, "The Theory of a 'French Air Menace'," 76.

⁴³ Ferris, "The Theory of a 'French Air Menace'," 76.

⁴⁴ Kirby and Capey, "The Air Defence of Great Britain, 1920-1940," 560.

⁴⁵ Smith, *British Air Strategy Between the Wars*, 125. Also in B. K. C. McKercher, "The Foreign Office, 1930-39: Strategy, Permanent Interests and National Security" in

international political situation and Germany's military build-up, the DRC issued a report on 28 February 1934 declaring, "Germany was the ultimate potential enemy and that all long-term planning would have to be framed with that country in mind."⁴⁶ The report also stipulated that the RAF should be given priority in the rearmament of the British military.⁴⁷ This priority was based primarily on a fear of air attack on Britain's cities.⁴⁸

Fear of a German air threat became more justified on 15 March 1934, when Germany officially refused to accept Part V of the Treaty of Versailles, introduced military conscription, and announced the formation of the Luftwaffe, the German Air Force.⁴⁹ By May of the same year, British Air Intelligence was tracking the abnormally rapid growth of the Luftwaffe in the short time since the Nazi take-over.⁵⁰

In response to the drastic rise of the Luftwaffe, Britain initiated an RAF rearmament initiative in June 1934. The purpose of this initiative was to provide Britain with parity in front-line strength to the Luftwaffe in the hopes that equality in striking power would deter German aggression and keep German grievances on the negotiating table and off the battlefield.⁵¹ In order to facilitate this strategy, Britain continually amended the RAF rearmament schedule to keep pace with the Luftwaffe buildup.

Foreign Office and British Diplomacy in the 20th Century, ed. Gaynor Johnson, (New York, NY: Routledge, 2005), 94.

⁴⁶ Smith, *British Air Strategy Between the Wars*, 129. Also in Wesley K. Wark, *The Ultimate Enemy: British Intelligence and Nazi Germany 1933-1939* (Ithaca, NY: Cornell University Press, 1985), 17.

⁴⁷ Smith, *British Air Strategy Between the Wars*, 137.

⁴⁸ Smith, *British Air Strategy Between the Wars*, 77.

⁴⁹ Smith, *British Air Strategy Between the Wars*, 149. Also in History Learning Site, "Germany and Rearmament," *History Learning Site*, http://www.historylearningsite.co.uk/germany_and_rearmament.htm (accessed 23 March 2013).

⁵⁰ Smith, *British Air Strategy Between the Wars*, 132.

⁵¹ Smith, *British Air Strategy Between the Wars*, 144. Also in Robertson, *The Development of RAF Strategic Bombing Doctrine*, 146.

By 1937, however, the pace of Luftwaffe growth was such that Sir Thomas Inskip recommended a change in British strategy. Rather than deterring Germany with parity in front-line strength, Britain would deter German aggression by creating an air defense system. This air defense system would deter Germany with the threat of a long war in the event of German aggression by making German air action against Britain a costly endeavor. Even though the strategy for dealing with Germany's military build-up changed, Britain continued to adjust its strategy to handle the perceived threat: "the very live fear that the men who now ruled Germany might well be prepared to unleash Armageddon to achieve their ends."⁵²

What was public opinion concerning the perceived threat?

British concern with an attack from the air prior to World War II had a long history. In 1907, shortly after the invention of the airplane by the Wright Brothers in 1903, H. G. Wells wrote his famous novel *The War in the Air*. In the book, Wells explains "that with the flying machine war alters in its character; it ceases to be an affair of 'fronts' and becomes an affair of 'areas'; neither side, victor or loser, remains immune from the gravest injuries, and while there is a vast increase in the destructiveness of war, there is also an increased indecisiveness. Consequently 'War in the Air' means social destruction instead of victory as the end of war."⁵³ This popular novel was just the beginning of popular cultural depictions of air warfare.

Within a few years, World War I exposed the British people to actual air attack. Air raids on Britain by German airships and bombers resulted in 1,413 deaths and 3,409 injuries.⁵⁴ Although the material damage and casualties were light compared to the damage and death toll

⁵² Smith, *British Air Strategy Between the Wars*, 109.

⁵³ H. G. Wells, *The War in the Air*, ed. Patrick Parrinder (New York, NY: Penguin Classics, 2005), 278.

⁵⁴ The National Archives, "Spotlights on History: Air Raids," *The National Archives*, <http://www.nationalarchives.gov.uk/pathways/firstworldwar/spotlights/airraids.htm> (accessed 22 February 2013).

along the western front, the British psyche was forever changed; the horrors of war had been brought to the civilian doorstep. Worse, it appeared there was nothing the country could do to stop air attacks in the future. For the 200 fighters and 450 guns used for home defense, the Germans only lost twenty bombers.⁵⁵ The British no longer felt that the country was an island protected from the outside world.⁵⁶

As a result of the dangers of air attack in World War I, concern for the conduct in future war led to more writings for public consumption. The prolific writer J. F. C. Fuller added his interpretation on the future impact of war in the air with his book, *The Reformation of War* in 1923. "Picture, if you can, what the result [of a mass aerial attack] will be: London for several days will be one vast raving Bedlam... the enemy will dictate the terms, which will be grasped at like a straw by a drowning man. Thus may a war be fought in forty-eight hours and the losses of the winning side may be actually nil!"⁵⁷ Although Fuller's works did not have the far reaching audience of Wells, this take on war in the air only added to the public opinion concerning the threat of air attack during a time of increasing tensions with the French air menace.

By the early 1930s, public concern over air attack was growing. As a result, Parliament and the Air Staff were forced to take note. Certain members of Parliament loudly called for British rearmament. In response, Lord President of the Council, Stanley Baldwin, in a speech made his famous statement that the bomber will always get through. In other words, there is nothing that can be done to protect the man on the street from aerial bombardment.⁵⁸ Furthermore, the Air Staff in 1933, in direct contrast with its strategy of a massive counter-offensive, grudgingly called for a certain amount of local defense against aerial

⁵⁵ Bungay, *The Most Dangerous Enemy*, 55.

⁵⁶ Bungay, *The Most Dangerous Enemy*, 56.

⁵⁷ J.F.C. Fuller, *The Reformation of War* (London, England: Hutchinson, 1923), 150.

⁵⁸ Kirby and Capey, "The Air Defence of Great Britain, 1920-1940," 557.

bombardment, “if only to appease the civilian population.”⁵⁹ Public opinion of the threat was forcing government action.

Then, in the mid-1930s, as Germany’s willingness to use its military buildup to force concessions on the international stage began to increase tensions in Europe, the threat of air attack continued to make its way into the media. In 1936, retired Air Commodore Lionel Charlton published a book, *War over England*, where he explained how Britain would be conquered in two days through the use of air power.⁶⁰ Around the same time, the film *Things to Come*, a screen rendition of an H.G. Wells writing, “summarized common fears: there would be no early warning, ground defenses would be useless, destruction would be immense and panic widespread.”⁶¹ The entertainment industry was continually feeding public opinion of the air threat.

What systems/technology did Great Britain put in place to detect and act upon that threat?

The basis for the British integrated air defense system that saved Britain in the Battle of Britain had its roots in the London Air Defense Area (LADA) system of World War I. The LADA consisted of three rings around London and a centralized command and control. The outer ring consisted only of anti-aircraft guns and searchlights. It was located about ten miles out from the heavily populated areas of the city and was designed to break up inbound raider formations. Furthermore, it was hoped that the searchlights and anti-aircraft bursts would get the attention of the fighters patrolling in the middle ring. The middle ring consisted exclusively of patrolling fighters. The majority of these fighters relied on the aid of searchlights to drive the intercept, while the remaining few fighters had the benefit of radio. If the fighters were unsuccessful, the inner ring, consisting of more searchlights and anti-

⁵⁹ Young, “British Home Air Defence Planning in the 1920s,” 506.

⁶⁰ Orange, Dowding of Fighter Command, 66.

⁶¹ Orange, Dowding of Fighter Command, 94.

aircraft guns as well as balloon apron barrages, got their turn. Coordinating the three rings was a central control room. Listening to German radio frequencies provided initial intelligence of a German raid. Once a raid was detected, it was up to a network of observation posts throughout the country to report any aircraft sightings up to the control room. Upon confirmation of a German raid by observation report, the fighters were ordered to take off and proceed to dedicated patrol areas.⁶² By November 1918, this system consisted of 16 fighter squadrons, 480 anti-aircraft guns, and 706 searchlights.⁶³ By the end of 1920, with post World War I disarmament, none of this system remained.⁶⁴

Although the Royal Flying Corps (RFC) success in the skies over London was rare, on occasion the RFC taught German pilots that the airspace was contested. One such RFC success occurred on 18 December 1917 when a patrol “became aware of a shadowy outline in the sky near Goodmayes in Essex.”⁶⁵ After successfully chasing the Gotha bomber down, the RFC pilot was able to destroy one engine and cripple the other. As a result, the bomber set down in the English Channel and after being towed to the English shore, exploded.⁶⁶ Unfortunately, these success stories were rare.

In 1922, as relations with France became strained, the British government again ordered the Air Staff to develop a plan for a local air defense system. This plan took much the same shape as the LADA. An aircraft defense zone with searchlights would form a crescent around London and provide a shield for the British capital and main industrial areas. Inside of the aircraft defense zone would be an inner anti-aircraft gun perimeter and anti-aircraft guns around important coastal points.

⁶² David Zimmerman, “Information and the Air Defence Revolution, 1917-1940,” *Journal of Strategic Studies* 27, no. 2 (2004): 371-372.

⁶³ Young, “British Home Air Defence Planning in the 1920s,” 493.

⁶⁴ Young, “British Home Air Defence Planning in the 1920s,” 493.

⁶⁵ Norris, *The Royal Flying Corps*, 224.

⁶⁶ Norris, *The Royal Flying Corps*, 224.

Providing early warning would be sound locator devices stationed along the coast. Aiding the inner and outer zones would be searchlights, observer personnel, and barrage balloon aprons. Fighters would still be required to fly patrols once notification of a raid occurred.⁶⁷ The LADA, although different in the number and shape of the defensive rings, had comprised all the same equipment and general operating procedures.

The controlling agency of this system would be the Air Defense of Great Britain (ADGB), created in 1925 and set to be ready in 1928.⁶⁸ However, relations with France improved in 1925 and popular demand for disarmament combined with a severe economic depression resulted in delaying the acquisition of the required fighter squadrons, anti-aircraft guns, and airfields.⁶⁹ Therefore, between 1925 and 1934, ADGB concentrated on planning the command structure and administrative processes that would be required to accomplish an effective air defense of Britain with the equipment the organization would eventually procure.⁷⁰ ADGB also completed multiple exercises to test the structure and processes with the equipment on hand.

By 1933, with the results of the previous six air exercises, the new commander of ADGB, Air Marshal Brooke-Popham, decided it was time to re-examine the air defense policy of ADGB. Over the previous decade many assumptions underlying ADGB's air defense policy were no longer valid. This was due to increases in the speed of bombers and fighters, as well as the fact that the distance from London to the coast remained constant. The time it would take bombers to reach London after being spotted was therefore decreasing, reducing the time available for fighters to take off, climb to altitude, and complete an intercept.⁷¹ The exercises

⁶⁷ Young, "British Home Air Defence Planning in the 1920s," 494-495.

⁶⁸ Orange, Dowding of Fighter Command, 57.

⁶⁹ Orange, Dowding of Fighter Command, 79.

⁷⁰ Young, "British Home Air Defence Planning in the 1920s," 500.

⁷¹ Young, "British Home Air Defence Planning in the 1920s," 505.

had shown that the air defense system needed unambiguous and timely notification of a raid and that an efficient communication network to relay this information were crucial. Furthermore, these elements needed to work in a harmonious, coordinated fashion. New and improved fighters would also be required to intercept these faster aircraft. Most importantly, the exercises had shown that, “not only was a defensive system necessary for the protection of the home country, in case the enemy’s air offensive started before Britain’s, but also that air defense by fighter aircraft, as the apex of a ground defense and intelligence network, was possible.”⁷² In response to these findings and in order to improve the air defense system, ADGB disappeared in July 1936 when the RAF was reorganized into Fighter Command and Bomber Command.⁷³

The reshuffling of priority from Bomber Command to Fighter Command did not occur until 1937 when Sir Thomas Inskip, Minister for the Co-Ordination of Defense, while reviewing British air programs for the purpose of reducing total costs, determined that the current RAF strategy was incorrect. “The role of the RAF, Inskip argued, had never been to launch a knockout blow, only to prevent the enemy trying one. Britain, on the contrary, must be able to confront the Germans with the risk of a long war, which superior British staying-power, based on her economic resources, would assuredly win.”⁷⁴ Inskip’s determination meant that the RAF should ensure the safety of Britain before attempting to destroy the enemy with a knockout blow. In order to accomplish this, the RAF would need “a system of pure defense against air attack to secure the home country as a base for later offensive power.”⁷⁵ Deterrence needed to switch from that of a knockout blow to that of the

⁷² Young, “British Home Air Defence Planning in the 1920s,” 506.

⁷³ Orange, *Dowding of Fighter Command*, 79.

⁷⁴ Smith, *British Air Strategy Between the Wars*, 183.

⁷⁵ Smith, *British Air Strategy Between the Wars*, 183.

threat of a long war with Britain, should Germany choose to attack.⁷⁶ Suddenly, development of a modern air defense system and its associated parts was begun in earnest. This system would incorporate radar for early warning, observer corps, modern fighters with radios and an identity friend or foe (IFF) capability, upgraded command and control, and associated ground based defenses.

Radar for Early Warning

The invention of radar in 1935 was to have the most profound effect on the new integrated air defense system. This one invention provided the ability to dispense with standing aircraft patrols and, therefore, put less stress on aircraft engines, waste less fuel, and put less stress on pilots and crews. In 1935, however, the technology was new and therefore no techniques for incorporating it into an air defense system existed.⁷⁷

The first radar trial in late February 1935 showed the capability for detecting an airplane up to eight miles away.⁷⁸ This early promise led to the development of a chain of radars along the coast known as Chain Home (CH). Initial plan in January 1936 was for 20 radar stations along the English coast from Southampton to the Tyne.⁷⁹ By April 1939, 11 radar stations were providing early warning along the south coast.⁸⁰ By 1 July 1940, there were 54 radar stations and by 30 September 1940 there were 76.⁸¹ However, these radars lacked the ability to detect targets attempting to penetrate English airspace from lower altitudes. In response to this coverage gap, the first low-looking radar station went into operation on 1 November 1939 and became part of the Chain Home

⁷⁶ Smith, *British Air Strategy Between the Wars*, 197.

⁷⁷ Orange, *Dowding of Fighter Command*, 82.

⁷⁸ Orange, *Dowding of Fighter Command*, 80.

⁷⁹ Kirby and Capey, "The Air Defence of Great Britain, 1920-1940," 560.

⁸⁰ Orange, *Dowding of Fighter Command*, 81.

⁸¹ Orange, *Dowding of Fighter Command*, 179.

Low (CHL) system.⁸² By the beginning of the Battle of Britain, CH and CHL coverage provided accurate early warning for most of Britain as seen in Figure 1. Postwar estimates of the usefulness of radar, prepared by Sir Charles Goodeve, showed that it increased the probability of a successful fighter interception by a factor of ten.⁸³

The German switch to night bombing in September 1940 also necessitated changes in the radar configuration. Ground-controlled-interception (GCI) radar was introduced. These radars added to the radars pointing out to sea by providing radar coverage inside Britain. These radars were controlled by sector operations rooms and made precise nighttime intercepts possible.⁸⁴ GCI radar in conjunction with ground observers provided the best capability of maintaining awareness on the size and position of all aircraft, friend or foe.

⁸² Orange, *Dowding of Fighter Command*, 152.

⁸³ Kirby and Capey, "The Air Defence of Great Britain, 1920-1940," 564.

⁸⁴ Zimmerman, "Information and the Air Defence Revolution," 391.

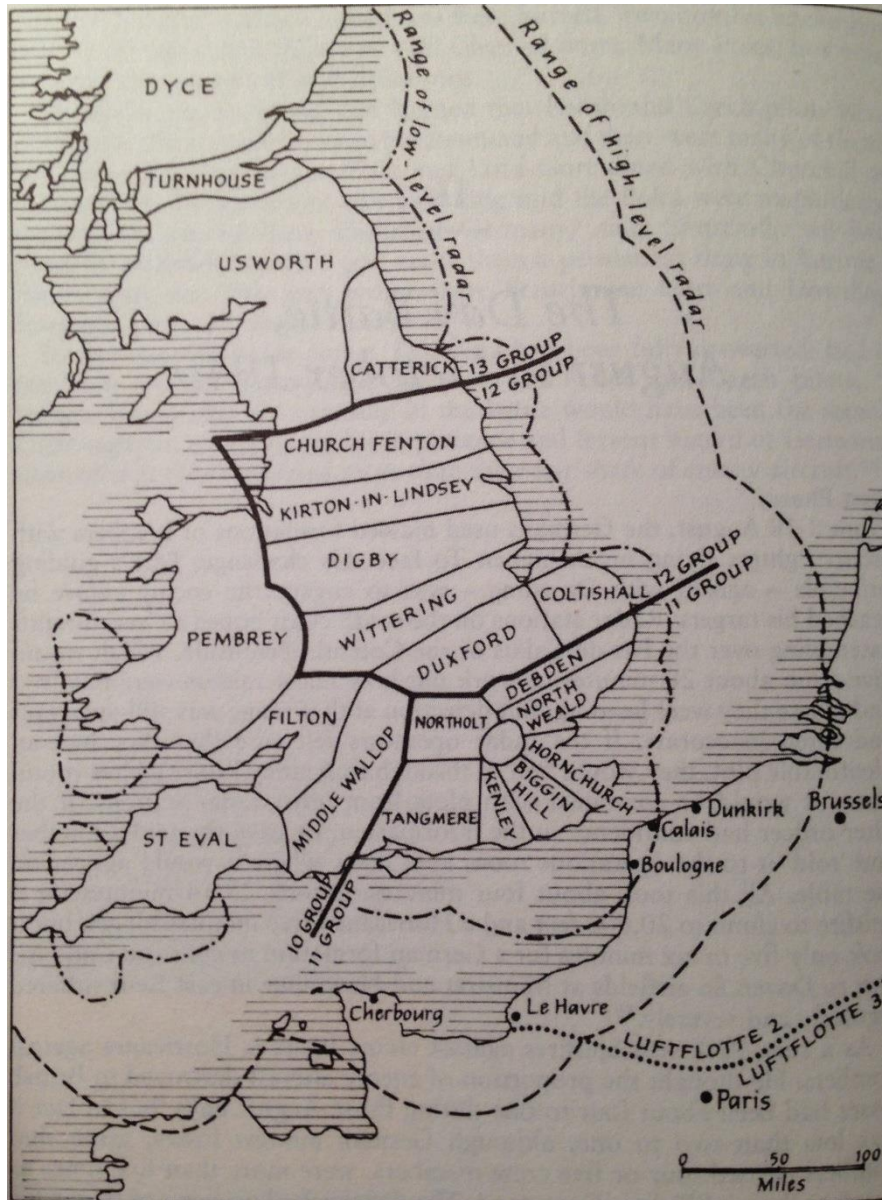


Figure 1: The Battle of Britain Air Defense Sectors and Radar Coverage

Source: Orange, Dowding of Fighter Command, 192.

Royal Observer Corps

The Observer Corps was originally established in 1925.⁸⁵ In January 1929, based on a recommendation by the Home Defense Sub-Committee to the CID, the Observer Corps was transferred from the War

⁸⁵ T. E. Winslow, *Forewarned is Forearmed: A History of the Royal Observer Corps* (London, England: William Hodge & Company, Limited, 1948), 28,

Office to the Air Ministry where its Commandant would work directly for ADGB.⁸⁶ The Observer Corps became the Royal Observer Corps (ROC) in April 1941 as a reward for the job it performed during the Battle of Britain.⁸⁷ The Observer Corps was an integral part of the air defense system because all radars that were initially located on the coast pointed out to sea. Therefore, the Observer Corps was the only source of information for any aircraft that crossed the English coast or managed to avoid radar detection. The Observer Corps provided this information by visually tracking the offending aircraft during the day.⁸⁸ Initially, the Observer Corps merely reported every aircraft that they saw or heard, but by the start of the war, the Corps was reporting the type of aircraft along with its estimated height, strength, and direction.⁸⁹ By night the Observer Corps tracked and provided estimated height and direction largely by sound.⁹⁰ “It also provided valuable information about friendly or enemy aircraft crashing near the posts, thus enabling police, military, fire and ambulance services to take necessary action as quickly as possible.”⁹¹

By 1940, the Observer Corps was about 30,000 strong, organized into 50 observer posts in each of 31 groups.⁹² The number of groups continued to increase through the end of 1940 and into 1941 and by June 1941 the Corps had 39 groups.⁹³ The posts were spaced from six to ten miles apart and were manned by men and women 24 hours a day, seven days a week through the end of the war.⁹⁴ Every post had a phone link to its group. The group then had a phone link to the Observer Corps

⁸⁶ Winslow, *Forewarned is Forearmed*, 31.

⁸⁷ H. Ramsden Whitty, *Observers' Tale: The Story of Group 17 of the R.O.C.* (London, England: Roland Brothers, 1950), 13.

⁸⁸ Bungay, *The Most Dangerous Enemy*, 62.

⁸⁹ Winslow, *Forewarned is Forearmed*, 57.

⁹⁰ Winslow, *Forewarned is Forearmed*, 62.

⁹¹ Orange, *Dowding of Fighter Command*, 57.

⁹² Bungay, *The Most Dangerous Enemy*, 62.

⁹³ Winslow, *Forewarned is Forearmed*, 73.

⁹⁴ Orange, *Dowding of Fighter Command*, 126.

Center at Horsham and then to Fighter Command HQ at Bentley Priory.⁹⁵ Together with radar, the Observer Corps provided the tracking information needed to launch British fighters to intercept the enemy formations and queue the ground-based defenses.

Modern Fighters

The two most influential fighters in the Battle of Britain were the Supermarine Spitfire and Hawker Hurricane. Initial plans for the Spitfire and Hurricane were submitted to the government in 1933, but due to limited funds did not get production requests until after 1936. The production requests were a result of the post-1936 rearmament. This plan also led to the development of an improved eight-gun system for the new monoplane designs. The monoplane design with eight-gun armament, IFF, and wireless radio-telephone in conjunction with radar and Royal Observer Corps (ROC) reporting, allowed the smaller RAF to apply airpower efficiently in the Battle of Britain.

The Hurricane flew for the first time on 6 November 1935, and the Spitfire appeared on 5 March 1936.⁹⁶ The Hurricane had a conventional build for the day consisting of a fabric-covered tubular steel frame. Therefore it was easy to build and able to withstand battle damage, but it burned easily. Although it stood up well in the upcoming battle, it was still outclassed by top German fighters.⁹⁷ The top German fighters referred to here were the Messerschmitt Bf 109 and Bf 110.⁹⁸ The Spitfire, on the other hand, was constructed with stressed-skin metal. This meant that it was difficult to build and could not withstand as much battle damage as the Hurricane, but it would not burn as easily. Furthermore, by the end of the war, the Spitfire's performance still

⁹⁵ Bungay, *The Most Dangerous Enemy*, 62.

⁹⁶ John Frayn Turner, *British Aircraft of World War II* (Briarcliff Manor, NY: Stein and Day, 1975), 33, 47.

⁹⁷ Orange, *Dowding of Fighter Command*, 72.

⁹⁸ Kenneth Munson, *German Aircraft of World War 2* (Poole, Dorset: Blandford Press Ltd, 1978), 10.

matched or exceeded the capability of top German fighters.⁹⁹ A comparison of aircraft information is shown in Figure 2.

Aircraft Variant ⁵	Hurricane (Hawker) ¹ Mk I B	Spitfire (Supermarine) ² Mk I	Bf 109 (Messerschmitt) ³ E-3	Bf 110 (Messerschmitt) ⁴ C-1
Maximum Speed	339 mph	357 mph	348 mph	336 mph
Service Ceiling	36,000'	37,200'	34,450'	32,810'
Range	470 miles	500 miles	410 miles	680 miles
Armament	12 x .303 caliber guns	8 x .303 caliber guns	2 x 7.9mm & 2 x 20mm	4 x 7.92mm & 2 x 20mm
Weight Empty	5,640 lb	no data	4,685 lb	10,770 lb
Weight Loaded	8,250 lb	6,527 lb	5,875 lb	13,294 lb
Engine	1,280 hp Rolls Royce Merlin XX	1,175 hp Rolls Royce Merlin II	1,175 hp DB 601 Aa	2,000 hp DB 601 A-1

Figure 2: Battle of Britain fighter comparison

Source: Author's Original Work

Note 1: John Frayn Turner, *British Aircraft of World War II* (Briarcliff Manor, NY: Stein and Day, 1975), 32-33.

Note 2: Turner, *British Aircraft of World War II*, 46-47.

Note 3: Kenneth Munson, *German Aircraft of World War 2* (Poole, Dorset: Blandford Press Ltd, 1978), 122-124.

Note 4: Munson, *German Aircraft of World War 2*, 124-125.

Note 5: Variant most commonly used in the Battle of Britain

Performance aside, “the Hurricane was flown by about six out of every ten squadrons [in the Battle of Britain], and it accounted for more enemy aircraft destroyed than any other type of British aircraft.”¹⁰⁰ By the outbreak of the war, 18 squadrons were equipped with Hurricanes and nine squadrons were equipped with Spitfires.¹⁰¹ These squadrons were complemented with 13 squadrons equipped with useless older models. Just across the Channel, the Air Ministry thought the Luftwaffe had 1,650 bombers (it was actually only 1,000).¹⁰²

At the time, it was believed that pilots could not handle the stresses of high speed maneuvering. Therefore conventional thought required a fighter to achieve maximum damage on an enemy bomber in one pass. The current four-gun configuration, it was calculated, would

⁹⁹ Orange, Dowding of Fighter Command, 72.

¹⁰⁰ Turner, *British Aircraft of World War II*, 33.

¹⁰¹ Orange, Dowding of Fighter Command, 72-73.

¹⁰² Orange, Dowding of Fighter Command, 146.

not achieve enough hits to do the job.¹⁰³ As a result, the Hurricane and Spitfire were each equipped eight .303 machine guns.¹⁰⁴

Pilots also needed a way to take advantage of the known position of enemy aircraft made available by the use of radar and the ROC. The incorporation of radios into the Hurricane and Spitfire provided this capability. Up until the dawn of the Battle of Britain, Fighter Command had to rely on High Frequency (HF) equipment. However, HF was not as useful as the newer Very High Frequency (VHF) technology. The superior TR 1130 VHF radio was finally available in enough quantities in mid-August 1940.¹⁰⁵ These radios allowed ground control to provide timely point-outs to enemy aircraft as well as receive timely mission reports following interception.¹⁰⁶

It was an identity friend or foe (IFF) system, however, that kept needless intercepts of friendly aircraft to a minimum. Having to intercept every inbound aircraft could have overwhelmed an already stressed air defense system.¹⁰⁷ A solution to the IFF problem was not found until March 1939.¹⁰⁸ It was finally reliable enough on the eve of the Battle of Britain to put into operation. By the end of February 1940, only 258 aircraft, mostly bombers, were carrying the device. By October, however, almost every RAF aircraft was carrying the device.¹⁰⁹

The Hurricane and Spitfire provided the backbone of the British fighter force. The advancements in aircraft design, armament, IFF, and early warning combined to give Britain a fighting chance in the upcoming battle. But the fighters were few and had to cover a tremendous amount

¹⁰³ Orange, Dowding of Fighter Command, 72.

¹⁰⁴ Turner, *British Aircraft of World War II*, 33, 47.

¹⁰⁵ Orange, Dowding of Fighter Command, 112.

¹⁰⁶ Ferris, "Fighter Defence Before Fighter Command," 862.

¹⁰⁷ Orange, Dowding of Fighter Command, 111.

¹⁰⁸ Orange, Dowding of Fighter Command, 111.

¹⁰⁹ Robin Higham, *Two Roads to War: The French and British Air Arms From Versailles to Dunkirk* (Annapolis, MD: Naval Institute Press, 2012), 246.

of territory. To provide stronger defenses for key locations, the fighters were aided by ground-based defenses.

Ground-Based Defenses

Complementing the fighters in the air defense system were ground-based defenses comprised of anti-aircraft guns, barrage balloons, and searchlights. As of July 1936, there were only 60 guns and 120 searchlights in the country.¹¹⁰ As of 28 July 1939, there were 695 heavy anti-aircraft guns, many of them obsolete and according to plans there should have been 2,232.¹¹¹ Furthermore, Britain only had 180 guns larger than 50 mm in January 1938. That number increased to 540 in September 1939 and 1,140 during the Battle of Britain.¹¹² This gain did not come easy to the struggling Anti-Aircraft (AA) Command. Before the war, the Royal Navy claimed that they would provide supporting fire for the ground defenses thereby relieving AA Command of the need for as many guns. However, in September 1939, the Royal Navy backed out of the offer and instead tried to claim incoming guns for defense of the fleet anchorages. By the beginning of the Battle of Britain, Fighter Command headquarters was protected by only four guns. Other key locations were not much better off. For example, 22 guns protected the Rolls-Royce factory and eight guns protected the Bristol aircraft factory. The Royal Navy's Rosyth base in Scotland, however, had 96.¹¹³

Aiding the anti-aircraft guns were barrage balloons. On 3 September 1939, 624 balloons were flown in response to the first air raid warning.¹¹⁴ The commander of Fighter Command, Dowding, ruled that "they were to be flown at all times, throughout the country, except when

¹¹⁰ Orange, Dowding of Fighter Command, 92.

¹¹¹ Orange, Dowding of Fighter Command, 128.

¹¹² Kenneth P. Werrell, *Archie to SAM: A Short Operational History of Ground-Based Air Defense* (Maxwell AFB, AL: Air University Press, 2005), 6.

¹¹³ Len Deighton, *Battle of Britain* (London, England: George Rainbird Limited, 1980), 180.

¹¹⁴ Orange, Dowding of Fighter Command, 126.

the local barrage commander decided the weather was too bad and except near aerodromes, where a station commander could rule that they were interfering with flying.”¹¹⁵ By the end of July 1940, 1,466 balloons were deployed around key locations in Britain. Behind each balloon was a 12-man crew responsible for raising and lowering as required. The primary purpose of the balloons was to discourage enemy aircraft from accomplishing low strafing runs.¹¹⁶

The anti-aircraft guns, barrage balloons, and searchlights were not responsible for very many German aircraft losses, but they did force the Germans to fly higher and therefore reduced German bombing accuracy. This was due to the fact that searchlights were only effective up to about 12,000 feet and anti-aircraft guns were only effective up to 25,000 feet.¹¹⁷ Furthermore, it quickly became clear that the searchlights also aided the Germans in finding London, and, for the remainder of the Battle of Britain, searchlights remained off except to highlight specific enemy aircraft already being tracked.¹¹⁸ The other advantage of the ground-based air defenses was that the constant barrage of gunfire and visibility of barrage balloons provided a calming effect for the people.¹¹⁹ None of the defenses, air or ground based, mattered, though, without an effective system to control them.

What was the system for command and control?

The backbone of Britain’s modern air defense system was the upgraded command and control system. Although built on the LADA model, Fighter Command did not possess the number of fighters required to wage a successful defensive war without a command and control system able to take advantage of radar and radios. Based on pre-war

¹¹⁵ Orange, Dowding of Fighter Command, 126.

¹¹⁶ Deighton, *Battle of Britain*, 181.

¹¹⁷ Leonard Mosley, *Battle of Britain*, ed. Time Life Books (Alexandria, VA: Time Life Books, 1977), 143. Also in Deighton, *Battle of Britain*, 181.

¹¹⁸ Deighton, *Battle of Britain*, 180.

¹¹⁹ Orange, Dowding of Fighter Command, 129. Also in Mosley, *Battle of Britain*, 145.

estimates, a force of 120 fighter squadrons was required to do the job. Fighter Command had approximately half that number during the Battle of Britain. Therefore, Fighter Command had to offset its numerical disadvantage by operating efficiently and economically.¹²⁰ The only way to accomplish this was to have an efficient means of gathering and disseminating information.

Radar was the first detection line. Once enemy aircraft were over England or avoiding radar by flying below the coverage, the Observer Corps tracked aircraft visually. By 1940 the ROC was about 30,000 strong organized into 50 observer posts in each of 31 groups. Every post had a phone link to its group, which in turn had a phone link to the Observer Corps Center at Horsham and then to Fighter Command Headquarters (HQ) at Bentley Priory.¹²¹ All decisions concerning intercepts were made at Fighter Command HQ and then sent down to the correct fighter group to execute the intercept. There were four fighter groups. 10 Group covered the southwest, 11 Group covered the southeast, 12 Group covered the midlands, and 13 Group covered the north and Scotland. Each group was split into sectors and each sector could control up to six squadrons but usually only controlled two or three squadrons. Finally, antiaircraft artillery was also coordinated in Fighter Command HQ between Fighter Command's commander, Dowding, and the anti-aircraft Commander, Frederick Pile.¹²²

Within Fighter Command HQ were a filter room and operations room. The purpose of the filter room was to take all observer corps and radar data to determine the actual number and size of German raids. Once the data was filtered, it was then passed to the operations room to direct the appropriate response. Kirby and Capey in their article, *The Air*

¹²⁰ Kirby and Capey, "The Air Defence of Great Britain, 1920-1940," 564.

¹²¹ Bungay, *The Most Dangerous Enemy*, 62.

¹²² Bungay, *The Most Dangerous Enemy*, 62-64.

Defence of Great Britain, 1920-1940: An Operational Research Perspective, give this explanation of the inner workings of the filter room:

Observations from the radar stations were plotted on single diagram in a filter room. This process was referred to as Plan Position Filtering, and the derived locations were then passed on to the relevant operations rooms at command, group, and sector levels where appropriate reactions by fighters, ack-ack and civil defence were planned. Information on exact aircraft sightings was reported to observer centers from Observer Corps posts. This information, fed into the operations rooms, was used to confirm radar-based location estimates, and facilitated the plotting of previously unobserved aircraft.¹²³

Vincent Orange in his book, *Dowding of Fighter Command: Victor of the Battle of Britain*, explains the workings of the operations room:

On a dias sat the senior controller, flanked by assistants and liaison officers. All places on the dias were provided with communications to squadrons, to aircraft in the air, and to all other units and headquarters to which messages needed to be sent. Wireless operators sat in cubicles behind the dias in contact with airborne fighters. Radio cross-bearings of sector aircraft were plotted and the results passed to the main operations room. The senior controller could see at a glance plots of hostile raids as well as the movements of his own fighters, the state of the local weather, and the state of readiness of his squadrons. He could even see how much petrol and oxygen his airborne fighters had left.¹²⁴

The centralized command and control provided by this system of information gathering, filtering, decision-making, and information dissemination resulted in the effectiveness and efficiency needed to overcome Fighter Command's numerical disadvantage in the Battle of Britain.

¹²³ Kirby and Capey, "The Air Defence of Great Britain, 1920-1940," 563.

¹²⁴ Orange, *Dowding of Fighter Command*, 105.

What were the rules of engagement (ROE) for acting upon the threat?

The Rules of Engagement (ROE) for the Battle of Britain were much simpler than today. This was a function of the technology present at the time. There were no such things as beyond visual range (BVR) weapons. Therefore, every intercept had to be taken to within visual range. Once within visual range, it was the responsibility of the intercepting pilots to determine the nationality of the aircraft being intercepted. The use of IFF also helped this process, because IFF reduced the number of intercepts for friendly aircraft. As a result, the majority of directed intercepts ended up being enemy aircraft. That is not to say that mistakes did not happen. Sometimes mistakes in identification did result in friendly aircraft being attacked while returning from overseas bases.¹²⁵ Furthermore, there were also instances of multiple squadrons converging for the same intercept and then engaging each other. On 6 September 1939, incorrect radar data resulted in the belief that there were many hostiles over the Thames estuary. In fact, there was no raid, and reacting Spitfires shot down two Hurricanes, and a third Hurricane was shot down by anti-aircraft fire.¹²⁶ These mistakes, however, were few and far between.

What did this air defense system provide for future military capability?

This air defense system provided much to the future of air defense as well as the application of air power. First, this air defense system was the first to incorporate radar and develop the applicable techniques for its efficient use. Second, the development of GCI radar and procedures provided an all-weather interception capability. Third, this system was the first to develop and utilize reliable IFF. Finally, in conjunction with

¹²⁵ Orange, Dowding of Fighter Command, 111.

¹²⁶ Orange, Dowding of Fighter Command, 142-143.

the equipment, this was the first true application of centralized command and control with decentralized execution in air warfare.

How did it work?

The true mark of the effectiveness of an air defense system is its success or failure in combat. Typically, judging success should be as simple as determining which side won the war. Although Britain survived the Battle of Britain and eventually went on, aided by allies, to defeat Germany in World War II, the cost in men and equipment was significant on both sides. Since the objective for Britain was to avoid defeat until winter weather made a German seaborne invasion impossible in 1940, the air defense system was successful.¹²⁷

In July, the Luftwaffe had about 2,350 aircraft combat-ready. Of these 2,350 aircraft, the Luftwaffe had over 1,300 bombers and 1,050 fighters. Opposing this force, the British only had 750 modern fighters consisting of Hurricanes and Spitfires of which only 600 were combat-ready. Over August and September, both sides increased their combat-ready aircraft by about 10% each month.¹²⁸

At the conclusion of the Battle of Britain, in November 1940, total Fighter Command losses included more than 1,000 casualties and, in July alone, 114 fighters. That same month Bomber Command lost 64 bombers.¹²⁹ Of the 1,000 casualties, there were 537 pilots or aircrew and over 500 wounded or injured. This number is significant when compared to the total number of men who flew at least one mission.

¹²⁷ Orange, *Dowding of Fighter Command*, 174.

¹²⁸ Orange, *Dowding of Fighter Command*, 176. Also in Deighton, *Battle of Britain*, 92. RAF order of battle included 639 combat ready aircraft, of which only 523 were Hurricanes or Spitfires. Also in James Holland, *The Battle of Britain: Five Months that Changed History May – October 1940* (London, England: Transworld Publishers, 2010), 325. “On the first day of June, Dowding had had just 331 Spitfires and Hurricanes, but by the last day of the month had 587 ready and serviceable, with plenty more on their way.”

¹²⁹ Orange, *Dowding of Fighter Command*, 188. Also in Deighton, *Battle of Britain*, 115. RAF combat losses for the month of July were 76 and non-combat losses were 41 for a total of 117. These figures only include British Category 3 – lost, missing, or destroyed – and Luftwaffe 100% loss.

That number was 3,000, leading to a casualty rate of one in three men flying missions.¹³⁰ German losses, on the other hand, were even higher. The Luftwaffe had approximately 8,700 casualties.¹³¹ Luftwaffe aircraft losses were also higher than the British. In July alone, the Luftwaffe lost 301 aircraft from all causes with another 196 damaged.¹³² For every ten Fighter Command fighters lost, the Germans lost 19. The total aircraft numbers for the battle were 1,023 British losses to 1,887 German losses.¹³³ Taking into account aircraft lost by the other commands, Bomber and Coastal, though, results in 1,547 aircraft lost, just 20% less than the Luftwaffe.¹³⁴

The Germans mounted the most significant raid on 15 September 1940 and became known as Battle of Britain Day. The Luftwaffe flew about 400 bombers and 700 fighters against London. Fighter Command sent up nearly 300 fighters to meet the raid. Although the Air Ministry claimed 185 German losses, the true figure was more modest, but still a success for Fighter Command. Actual German aircraft losses were 56 to Fighter Command's 26 losses.¹³⁵ Added to the German losses were "several dozen more Luftwaffe bombers [that] limped back to base with some crew members dead, engines ablaze and undercarriages shot away."¹³⁶ Furthermore, at least 20 Messerschmitt Bf-109 were forced to

¹³⁰ Orange, *Dowding of Fighter Command*, 176. Also in Deighton, *Battle of Britain*, 178. 3,080 aircrew are officially listed as having taken part in the Battle of Britain. Of these, 520 died during the battle. Of the 3,080 aircrew, 2,543 were British born. Of these, 418 were killed during the battle.

¹³¹ Orange, *Dowding of Fighter Command*, 176.

¹³² Orange, *Dowding of Fighter Command*, 189. Also in Deighton, *Battle of Britain*, 115. Luftwaffe combat losses for the month of July were 190 and non-combat losses were 35 for a total of 225. These figures only include British Category 3 – lost, missing, or destroyed – and Luftwaffe 100% loss.

¹³³ Orange, *Dowding of Fighter Command*, 177. Also in Holland, *The Battle of Britain*, 422. "The Luftwaffe had lost over 200 aircraft in July, Fighter Command half that." Although the actual numbers differ, the relative ratio of loss; two German aircraft to every British aircraft remains fairly constant between sources.

¹³⁴ Bungay, *The Most Dangerous Enemy*, 368.

¹³⁵ Mosley, *Battle of Britain*, 123.

¹³⁶ Mosley, *Battle of Britain*, 123.

land in the water on their way back to France due to running out of fuel. The German losses on the raid signified the turning point of the Battle of Britain; Operation Sealion was postponed indefinitely.¹³⁷

Fighter Command won the Battle of Britain. In order to accomplish this feat, Fighter Command also used an air reserve system. This system ensured that no matter where the Luftwaffe attacked, they would face continuous pressure by intercepting fighters. The largest fighting unit used by the British was a squadron. Therefore, as the German raid progressed inland, they would be met by intercepting fighters. If that interception failed to turn the raid back, another squadron would get assigned a follow-on intercept, and this process was continued until the raid was destroyed, turned back, or completed the mission.¹³⁸ The constant British resistance resulted in Hitler postponing Operation Sealion, the German seaborne invasion plan, until further notice on 17 September 1940.¹³⁹ By the end of October, facing worsening weather over Britain, German attacks declined significantly. Furthermore, by early May 1941, demands for equipment and personnel in preparation for Operation Barbarossa forced Germany to shift the Luftwaffe weight of effort away from Britain.¹⁴⁰ Fighting continued over the English Channel after 31 October 1940, but only sporadically and rarely with enough force to overwhelm the air defense system and never to target the air defense system under the control of Fighter Command.

¹³⁷ Mosley, *Battle of Britain*, 123.

¹³⁸ Orange, *Dowding of Fighter Command*, 177.

¹³⁹ Orange, *Dowding of Fighter Command*, 198.

¹⁴⁰ Mosley, *Battle of Britain*, 183.

Chapter 4

Case Study 2: United States Dedicated Air Defense System Post World War II

Much like Great Britain, the United States enjoyed the relative security associated with being an island nation. Furthermore, the expanse of water separating the United States from potential enemies was not a channel, but instead oceans. Therefore, unlike Britain, the arrival of the airplane as a weapon of war in World War I did not have the same impact on the United States as it did on Britain. Rather, it was the technological advances made in World War II associated with the bomber; payload and range, combined with a potential adversary's acquisition of the atomic bomb that spawned the United States air defense system of the 1950s and 60s.

This case study attempts to answer several questions. First, why did the United States build an integrated air defense system immediately following WWII? Second, what was the perceived threat? Third, what was public opinion concerning the perceived threat? Fourth, what systems/technology did the United States put in place to detect and act upon that threat? Fifth, what was the system for command and control? Sixth, what were the rules of engagement (ROE) for acting upon the threat? Seventh, what did this air defense system provide for future military capability? Finally, how did the system work?

Why did the United States build an integrated air defense system immediately following WWII?

Ideological differences between the communist Soviet Union and the Western democracies began to create tension as soon as their alliance against an aggressive Germany formed. This uneasy alliance formed shortly after Germany initiated war with the Soviet Union on 22

June 1941.¹ Due to their initial significant losses of men and equipment, the Soviet Union immediately pleaded for a British invasion of France to force the German's to reallocate force to a western front, and in doing so, relieve pressure on Soviet troops on the eastern front. In 1942, President Roosevelt promised to accomplish the invasion that autumn. However, the invasion was then postponed until 1943 and when the Allies again postponed the invasion until 1944, Stalin exploded. As a result, the Soviet Union recalled their ambassadors from London and Washington.²

Throughout the alliance, the United States and Britain continued to make concessions to the Soviet Union in order to maintain the alliance. In August 1941, Winston Churchill and Franklin Roosevelt met and decided on the Atlantic Charter in which they formally agreed "that the Allies would not accept territorial changes resulting from the war in Europe."³ However, in November 1943 at the Tehran Conference, the first conference between Stalin, Churchill, and Roosevelt, "Stalin pressed for a revision of Poland's eastern border with the Soviet Union to match the line set by British Foreign Secretary Lord Curzon in 1920. In order to compensate Poland for the resulting loss of territory, the three leaders agreed to move the German-Polish border to the Oder and Neisse rivers. This decision was not formally ratified, however, until the Potsdam Conference of 1945. During these negotiations Roosevelt also secured from Stalin his assurance that the Republics of Lithuania, Latvia, and Estonia would be reincorporated into the Soviet Union only after the

¹ Von Hardesty and Ilya Grinberg, *Red Pheonix Rising: The Soviet Air Force in World War II* (Lawrence, KS: University Press of Kansas, 2012), 5.

² Office of the Historian, "MILESTONES: 1937-1945, U.S.-Soviet Alliance, 1941-1945," *US Department of State*, <http://history.state.gov/milestones/1937-1945/USSoviet> (accessed 19 January 2013).

³ Office of the Historian, "MILESTONES: 1937-1945, Wartime Conferences, 1941-1945," *US Department of State*, <http://history.state.gov/milestones/1937-1945/WarTimeConferences> (accessed 19 Jan 2013).

citizens of each republic voted on the question in a referendum.”⁴

Disagreements between the three powers did not end at Tehran, further concessions occurred at the Yalta Conference in February 1945 as a result of disagreements.

Represented at the Yalta Conference were the United States, Britain, and the Soviet Union. At Yalta, as compared to the Tehran Conference, the Allied leaders knew that victory over Germany was practically inevitable.⁵ One of the discussion points was the treatment of Germany following victory and included the control machinery and the zones of occupation, boundaries, and long-range economic policies. Britain and the United States were for four zones of occupation so as to include France in the occupation and control of occupied Germany, whereas the Soviet Union was against French involvement. Furthermore, the Soviet Union wanted to leave Germany with only 80% of its industrial capacity as well as massive reparations. Britain and the United States, on the other hand, were against severely reducing Germany’s industrial capacity and against severe reparations. The final agreement consisted of setting up a commission to study reparations and an agreement on a French zone of control with representation on the Control Commission.⁶

Another major point of discussion was the Declaration on Liberated Europe. The Declaration stated in part:

⁴ Office of the Historian, “MILESTONES: 1937-1945, The Tehran Conference, 1943,” *US Department of State*, <http://history.state.gov/milestones/1937-1945/TehranConf> (accessed 19 Jan 2013).

⁵ Office of the Historian, “MILESTONES: 1937-1945, The Yalta Conference, 1945,” *US Department of State*, <http://history.state.gov/milestones/1937-1945/YaltaConf> (accessed 27 March 2013).

⁶ Edward R. Stettinius, Jr., *Roosevelt and the Russians: The Yalta Conference* (Garden City, NY: Doubleday & Company, Inc., 1949), 121-133, 299. Also in Winston S. Churchill, *Triumph and Tragedy* (New York, NY: Houghton Mifflin Company, 1953), 301-303. Also in James F. Byrnes, *Yalta: High Tide of Big Three Unity* in *The Yalta Conference*, 2nd ed., ed. Richard F. Fenno, Jr. (Lexington, MA: D. C. Heath and Company, 1972), 28-33. Also in *The Yalta Conference, The Crimea (Yalta) Conference: Documents: Protocol of Proceedings, February 11, 1945* in *The Yalta Conference*, 2nd ed., ed. Richard F. Fenno, Jr. (Lexington, MA: D. C. Heath and Company, 1972), 50-51.

[The United States, Britain, and the Soviet Union] declare their mutual agreement to concert during the temporary period of instability in liberated Europe the policies of their three governments in assisting the peoples liberated from the domination of Nazi Germany and the peoples of the former Axis satellite states of Europe to solve by democratic means their pressing political and economic problems... This is a principle of the Atlantic Charter – the right of all peoples to choose the form of government under which they will live – the restoration of sovereign rights to self-government to those peoples who have been forcibly deprived of them by the aggressor nations.⁷

Initially, Stalin proposed two amendments, but under opposition by President Roosevelt withdrew his request. The agreement on the Declaration appeared to be united between the three powers, but would shortly become a major source of contention.

Another perceived victory at Yalta that would eventually become a major source of contention between the United States and the Soviet Union was the issue of Poland. Included in this issue were the eastern and western boundaries of Poland as well as the Provisional Polish Government established by the Soviet Union. The Soviet Union wanted to make Poland's western boundary the Neisse River and to return portions of eastern Poland to the Soviet Union. The United States and Britain opposed moving the western boundary and requested minor deviations of the eastern boundary as requested by the Soviet Union. The primary sticking point, however, was the provisional government. The United States and Britain wanted a reorganization to include democratic leaders from outside Poland with free elections held at the earliest possible date whereas the Soviet Union only thought the government should be expanded. Ultimately, the Soviet Union agreed not to move the western boundary, made some concessions on the

⁷ Stettinius, Roosevelt and the Russians, 242-243. Also in The Yalta Conference, The Crimea (Yalta) Conference: Documents, 48-49.

eastern boundary, and agreed to a reorganization of the provisional government with free elections held at an early time.⁸

The final major issue of discussion pertained to Russian entry into the war in the Pacific. At the urging of the Joint Chiefs of Staff, and knowing that victory over Japan could be costly, the United States sought Soviet intervention in the Pacific theater. The Soviet Union agreed to declare war on Japan within two to three months following the German surrender in return for territorial gains thus providing a sphere of influence in the region. These included maintaining the status quo in Outer Mongolia, territory taken by Japan in 1904 restored to the Soviet Union, and the Kurile Islands which had been claimed by both Japan and the Soviet Union prior to 1904. Although this agreement granted territorial concessions, an item specifically decided against in Europe by the Atlantic Charter, this was considered the major concrete accomplishment at the Yalta Conference.⁹

The largest disagreement at the Potsdam Conference in July 1945, following the defeat of Germany, still dealt with the movement of the Polish and German borders. However, Great Britain and the United States approved the concessions in order to keep Soviet support in the war in the Pacific. Furthermore, terms for transitioning from the four-way division of Germany to a single German government were postponed due to disagreements between the Soviet Union and the western democracies.¹⁰

⁸ Stettinius, *Roosevelt and the Russians*, 301-302. Also in Churchill, *Triumph and Tragedy*, 327. Also in The Yalta Conference, *The Crimea (Yalta) Conference: Documents*, 51-52.

⁹ Office of the Historian, "MILESTONES: 1937-1945, The Yalta Conference." Also in Stettinius, *Roosevelt and the Russians*, 90, 93. Also in Churchill, *Triumph and Tragedy*, 334. Also in Byrnes, *Yalta: High Tide of Big Three Unity*, 42. Also in *The Crimea (Yalta) Conference: Documents*, 54-55.

¹⁰ Office of the Historian, "MILESTONES: 1937-1945, The Potsdam Conference, 1945," *US Department of State*, <http://history.state.gov/milestones/1937-1945/PotsdamConf> (accessed 19 Jan 2013). Also in Churchill, *Triumph and Tragedy*, 556-559.

As much as Yalta and Potsdam Conferences appeared to set the stage for future cooperation between Britain, the United States, and the Soviet Union, events quickly showed this was not to be. The acting Secretary of State at the time, Edward Stettinius, stated, "The Russians delayed on certain military agreements; they impeded the formation of the German Control Commission; they failed to live up to the Declaration of Liberated Europe as applied to Romania; and they greatly impeded execution of the Polish agreement."¹¹ Over the next couple years, Soviet failure to act on prior agreements and suspicions over the western democracy's intentions further strained and eventually ended cooperation.¹²

Within three years of the surrender of Japan, disagreements over German reparations and the future of reunification of Germany reached the boiling point. On 24 June 1948 the Soviet Union severed all land and water communications and traffic between the western occupied zones and their respective Berlin zones.¹³ The western democracies had only one avenue available to supply their forces and the German population in western occupied Berlin; air traffic. What followed was the best example of airpower through airlift in history. Over the course of the next 15 months, the United States, Great Britain, and France delivered a total of 2,325,509.6 tons of cargo and supplies to Berlin.¹⁴ The Soviet Union finally reopened land and water routes to Berlin, but it was clear that the differences between the western democracies and the

¹¹ Stettinius, *Roosevelt and the Russians*, 311.

¹² W. Averell Harriman, *Statement Regarding Our Wartime Relations with the U.S.S.R., Particularly Concerning the Yalta Agreement* in *The Yalta Conference*, 2nd ed., ed. Richard F. Fenno, Jr. (Lexington, MA: D. C. Heath and Company, 1972), 114. Another example of Soviet failure to follow the Yalta agreements concerned the actual meeting between China and the Soviet Union where Stalin "made demands that went substantially beyond the Yalta understanding."

¹³ Roger G. Miller, *To Save a City: The Berlin Airlift, 1948-1949* (College Station, TX: Texas A&M University Press, 2000), 32.

¹⁴ Miller, *To Save a City*, 186.

Soviet Union were real and not easily rectified. Then, on 29 August 1949, the Soviet Union exploded their first atomic bomb.¹⁵

What was the perceived threat?

The combination of three factors led to the perception that the Soviet Union posed a threat to the national security of the United States. The first factor was the ideological differences between the communist Soviet Union and the democratic United States. “Official ideology of the Soviet Union was to seek the eradication of capitalist regimes like the United States.”¹⁶ The second factor was the discovery that the Soviets had reverse engineered the B-29. The range of the B-29 using great circle routes made much of the United States vulnerable to air attack. The third factor was the Soviet Union’s successful detonation of an atomic bomb. Combined, these three factors posed a threat to the United States too serious to ignore.

In late 1944, the Soviet Union acquired four American B-29 long-range bombers. The Soviet Union first sought acquisition of the B-29 via the Lend-Lease agreement with the United States. Soviet requests for the B-29, however, were denied multiple times. Therefore, when a B-29 made an emergency landing in Vladivostok, the Soviet Union interred the crew and refused to return the aircraft. This B-29 took off from Chengtu, China on 31 July 1944 to attack targets in Japanese held Manchuria. Due to a late takeoff the crew burned extra fuel using high power settings to catch up with its formation. Following the scheduled bomb run, the number three engine ran away. When attempts to feather the propeller failed, the crew realized they did not have the fuel necessary to return to Chengtu. Rather than setting the airplane down in Japanese territory, the crew decided to land in the Soviet Union under the

¹⁵ Neil Sheehan, *A Fiery Peace in a Cold War: Bernard Schriever and the Ultimate Weapon* (New York, NY: Vintage Books, 2009), 99.

¹⁶ Campbell Craig, *Destroying the Village: Eisenhower and Thermonuclear War* (New York, NY: Columbia University Press, 1998), 3.

assumption that the United States' ally would allow them to fuel and then return to base. Instead, the Soviet Union held the crew for seven months before returning them to the United States without their airplane. The Soviet Union eventually acquired three more B-29s in similar fashion: two executed similar emergency landings in Vladivostok and one crash-landed in Siberia.¹⁷ Although failure to return the aircraft to the United States created a source of tension between the nations, it was what the Soviet Union did with the aircraft that threatened the United States.

In August 1947, the Soviet Union flew three Tupolev Tu-4s in a public airshow at Tushino airfield just outside Moscow. Foreign observers initially thought the Tu-4s were the three B-29s detained by the Soviet Union. However, following the flyby of the three Tu-4s, a passenger variant of the aircraft made an appearance. The appearance of this passenger variant clearly showed that these bombers were of Soviet design. All of a sudden, the western democracies realized that the Soviet Union, by reverse engineering the B-29, had begun to build a long-range bomber force.¹⁸ Furthermore, the B-29, as manufactured by Boeing, had a range of 5,830 miles.¹⁹ Assuming that the Soviet Tu-4 had the same range, flights originating in Siberia could place much of the United States at risk of air attack (See Figure 3).

¹⁷ National Museum of the US Air Force, "Soviet Union Impounds and Copies B-29," *National Museum of the US Air Force*, 4 December 2006, <http://www.nationalmuseum.af.mil/factsheets/factsheet.asp?id=1852> (accessed 21 January 2013).

¹⁸ Hardesty and Grinberg, *Red Phoenix Rising*, 352-353.

¹⁹ Boeing, "History: B-29 Superfortress," *Boeing*, <http://www.boeing.com/boeing/history/boeing/b29.page> (accessed 27 March 2013).

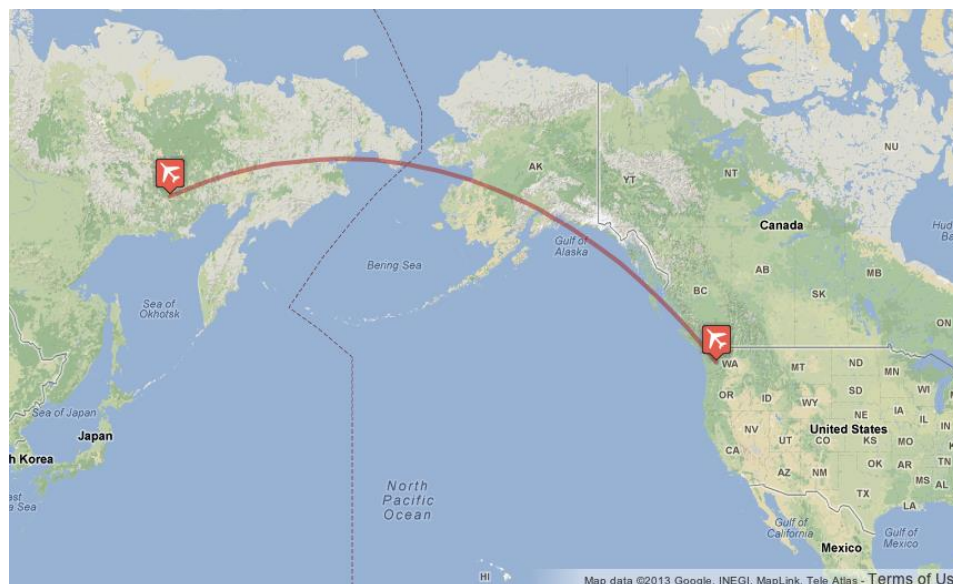


Figure 3: Sokol Airport to Seattle, Washington is 2,875 nautical miles

Source: Air Miles Calculator, “Distance from Sokol Airport (GDX) to Seattle Tacoma International Airport (SEA),” Air Miles Calculator, 27 March 2013, <http://www.airmilescalculator.com/distance/gdx-to-sea/> (accessed 27 March 2013).

Ideological differences and a long-range bomber capability did not necessarily pose a serious threat to the United States. Results of conventional bombing missions in World War II showed that achieving destruction of a single target required hundreds of bombers. Even if the Soviets built a massive bomber force, this kind of capability would put very little of the United States at risk at any given time. Nuclear bombs, on the other hand, changed all this. One or two nuclear bombs could wipe out an entire city. Hundreds of bombers, each armed with a nuclear bomb, could now destroy hundreds of cities.

“On September 3, 1949, an Air Force B-29 reported unusually high radioactivity measurements over the North Pacific near the Soviet Union’s Kamchatka Peninsula.”²⁰ Although many American experts

²⁰ Kenneth Schaffel, *The Emerging Shield: The Air Force and the Evolution of Continental Air Defense 1945-1960* (Washington, DC: Office of Air Force History, 1991), 111.

agreed that it would most likely be another three years before the Soviet Union acquired an atomic weapon, the Soviet Union had already taken steps to ensure it got the bomb in as short amount of time as possible.²¹ Even before Stalin ordered the “as quick as possible” nuclear bomb program in August 1945, Soviet intelligence had already gathered detailed information from two spies working within the Manhattan Project and one spy involved with nuclear armament plants in Oak Ridge, TN and Dayton, OH.²² This insider information probably cut a year to two years off the Soviet nuclear bomb program.²³ Therefore, although the Soviet Union detonated a nuclear bomb earlier than the United States had estimated, it was not a complete surprise that the Soviet Union had achieved nuclear weapon capability.²⁴

Given the ideological differences between the United States and the Soviet Union, along with the long-range strike capability of the Tu-4, a nuclear arsenal in the hands of the Soviets created a cause for concern. Craig Campbell in *Destroying the Village* summarizes this point. “For the first time in its history, the United States perceived a peacetime threat to its national survival. This threat derived from the existence of military technology capable of traversing the oceans, and of a regime potentially interested in using such technology for the purposes of conquering the United States.”²⁵ The perception that the United States was vulnerable to nuclear attack by Soviet long-range bombers would have far-reaching consequences.

²¹ C. L. Grant, USAF Historical Studies: No. 126, The Development of Continental Air Defense to 1 September 1954 (Maxwell AFB, AL: Research Studies Institute, Air University, 1957), 29-30.

²² Sheehan, *Fiery Peace in a Cold War*, 54-55.

²³ Sheehan, *Fiery Peace in a Cold War*, 101.

²⁴ Schaffel, *The Emerging Shield*, 111.

²⁵ Craig, *Destroying the Village*, 3.

What was public opinion concerning the perceived threat?

Following the Soviet explosion of an atomic bomb in August 1949, the American public was bombarded with information about nuclear weapons, nuclear warfare, and the United States Air Force's ability to protect America from a Soviet air attack. Radio, newspapers, magazines, and television attempted to keep the public informed. For those who felt threatened, and many did, the perceived threat was a nuclear bomb delivered by Soviet long-range bombers. Americans did not feel safe from air attack. "This feeling had briefly been held during WWII after attack on Pearl Harbor and an air defense command was started and then disbanded as military victories pushed back the Japanese and Germans. The oceans, it was thought, were defense enough."²⁶ The average American no longer viewed the oceans as wide enough to protect the United States.

Beginning in 1950, the popular Washington based columnists syndicated in over three hundred American newspapers, Joseph and Stewart Alsop, initiated a multi-year campaign to raise awareness of the sad state of the Air Force's air defense system.²⁷ Time Magazine published multiple articles concerning nuclear war and the new Air Force. In 1950, Time issued an article called "Atomic ABCs." This article was supposed to answer questions such as: "Will the Russians make an atom-bomb attack on the U.S.? If it comes, what is the defense? Is there any defense?"²⁸ A quick sampling of Time Magazine in the 1950s shows multiple articles dedicated to the people and mission of the United States Air Force such as the eight page "Armed Forces: The New Dimension" in Feb 1954 and the ten page "The U.S. Air Force: The Nation's Youngest

²⁶ L. Douglas Keeney, *15 Minutes: General Curtis LeMay and the Countdown to Nuclear Annihilation* (New York, NY: St. Martin's Press, 2011), 11.

²⁷ Keeney, *15 Minutes*, 91. Also in Schaffel, *The Emerging Shield*, 173. Also in Joseph and Stewart Alsop, "We Accuse!," *Harper's Magazine*, October 1954, 43.

²⁸ Time, "Atomic ABCs," *Time*, 21 August 1950, 16.

Service Has Entered the Supersonic Age” in March 1956.²⁹ As Steve Call stated in *Selling Air Power*, “Other media, especially film, might put the message in more vivid or memorable images, but the steady flow of magazine articles ensured that the public got numerous and frequent reminders that their faith must remain in nuclear air power.”³⁰ The American public appeared to know that the greatest threat to the United States was a nuclear attack delivered by Soviet long-range bombers and its savior would be the United States Air Force.³¹

Perhaps the greatest proof of the American public’s awareness of the threat and its perception of the severity of the threat was the civilian reaction to the Ground Observer Corps (GOC). Technological limitations of radar left a low-altitude gap in the radar coverage of the United States borders. In 1950, the only means available to spot enemy aircraft approaching the United States from low-altitude was therefore human observers.³² One year after its inception, the GOC had 210,000 volunteers supporting approximately 8,000 observation posts, many of which supported 24-hour operations by the late-1950s. By mid-1953, the GOC had over 305,000 volunteers.³³ Until January 1959, when the US Air Force deactivated GOC, many civilians willingly volunteered.³⁴

GOC recruiting was helped by the wealth of media coverage for the Air Force and its role in defense of the nation as well as targeted advertising. Air Force public relations advertised on the radio with announcements such as, “Who will strike the first blow in the next war, if and when it comes? America? Not very likely. No, the enemy will strike

²⁹ Time, “Armed Forces: The New Dimension,” *Time*, 8 February 1954, 18-25. Also Time, “The U.S. Air Force: The Nation’s Youngest Service Has Entered the Supersonic Age,” *Time*, 5 March 1956, 56-65.

³⁰ Steve Call, *Selling Air Power: Military Aviation and American Popular Culture after World War II* (College Station, TX: Texas A&M University Press, 2009), 103.

³¹ Call, *Selling Air Power*, 100.

³² Schaffel, *The Emerging Shield*, 156.

³³ Schaffel, *The Emerging Shield*, 159.

³⁴ Schaffel, *The Emerging Shield*, 222.

first. And they can do it too – right now the Kremlin has about a thousand planes within striking distance of your home.” Another announcement stated, “It may not be a very cheerful thought but the Reds right now have about a thousand bombers that are quite capable of destroying at least 89 American cities in one raid.”³⁵ Although directed recruiting helped the Air Force man the volunteer observer positions, public perception and awareness of the threat made recruiting easier.

As the 1950s concluded, it was clear that defending the United States against a Soviet nuclear threat was ingrained in the social construct. “In 1960, CBS, NBC, and ABC typically went off the air at 1:00 AM... On many occasions, they added pictures of [Strategic Air Command] bombers streaking across the sky.”³⁶ Then in 1964, Stanley Kubrick released the movie *Dr. Strangelove or: How I Learned to Stop Worrying and Love the Bomb*. The movie was nominated for four Oscars and won multiple international awards. In 2013, it was still listed as number 38 of the Internet Movie Database’s (IMDB) top 250 movies of all time.³⁷ American perception and awareness of the threat had spawned a hit satire of nuclear war. Although the flavor of popular culture’s depiction of air power had changed by the early-1960s, public awareness of the threat and the systems in place to defend against it were still high.³⁸

What systems/technology did the United States put in place to detect and act upon that threat?

In order to detect and act upon a threat, an air defense system needs sensors, shooters, and some means to communicate between the two. Sensors should include early warning and the ability to track a threat once early warning finds it. Finally, tracking a threat does no

³⁵ Quoted in Schaffel, *The Emerging Shield*, 158-159.

³⁶ Keeney, *15 Minutes*, 242.

³⁷ IMDB, “Dr. Strangelove or: How I Learned to Stop Worrying and Love the Bomb,” IMDB, <http://www.imdb.com/title/tt0057012/> (accessed 22 Jan 2013).

³⁸ Steve Call, *Selling Air Power*, 135.

good if there is no capability to neutralize the threat before it reaches its target. The shooters are responsible for neutralizing the threat.

Shooters consisted of aircraft, surface-to-air missiles, and antiaircraft artillery.

The first sensor line, designed to detect enemy bombers as far from the northern border of the United States as possible, was the Distant Early Warning (DEW) line. The next sensor line working towards the northern United States border was the Mid-Canada line. Finally, the Pinetree line was installed along the northern border of the United States (see Figure 4). Sensor coverage along the east and west coasts entailed US Navy picket ships and US Air Force early warning aircraft. The east coast coverage was also supplemented with Texas Towers. Finally, volunteers manning the Ground Observer Corps (GOC) provided low altitude coverage.

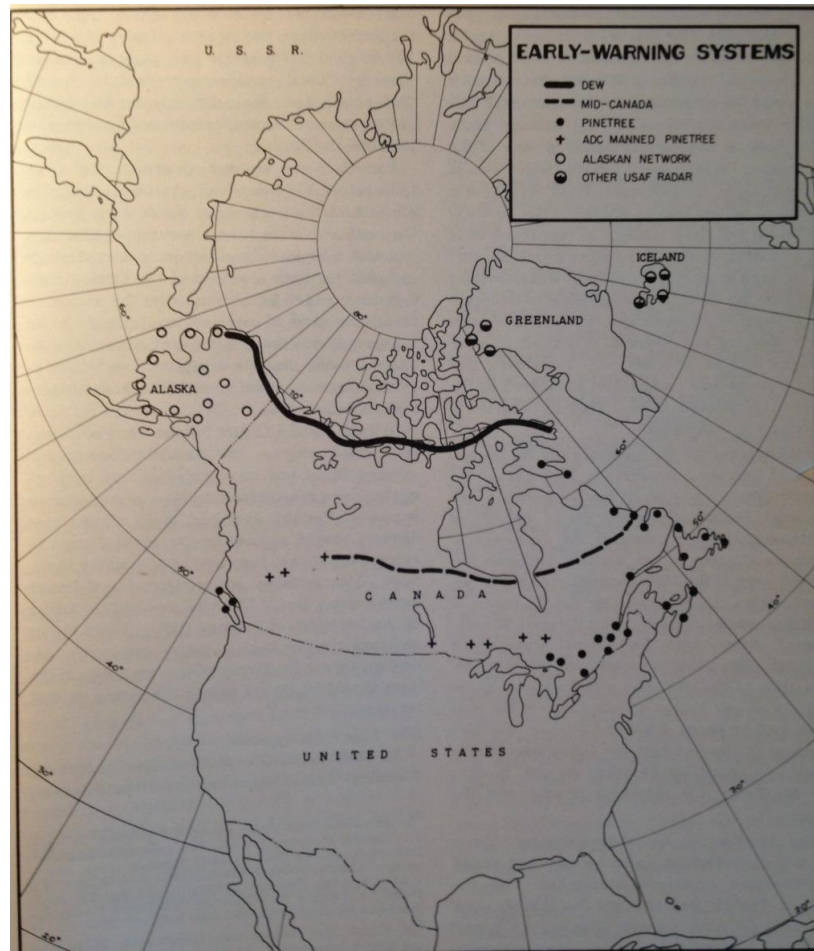


Figure 4: Early Warning Plan as of 1954

Source: Grant, USAF Historical Studies: No. 126, 63.

The Pinetree line consisted of a series of radar sites and control facilities on the United States and Canadian border. When the line went fully operational in June 1954, there were 33 aircraft control and warning sites. The United States Air Force manned 18 of the sites and the Royal Canadian Air Force manned the remaining 15. Furthermore, the United States paid for 22 of the sites with Canada paying for the remainder.³⁹

The Mid-Canada line consisted of a series of microwave towers forming a fence line approximately halfway between the United States

³⁹ Grant, USAF Historical Studies No. 126, 61.

northern border and the Arctic Circle. Unlike radars, the microwave fence only signaled when something flew by. Unfortunately, this line suffered from many false alarms as even a flock of geese would trigger an alarm. This line was paid for wholly by Canada.⁴⁰

The Distant Early Warning (DEW) line consisted of a series of radar sites inside the Arctic Circle following a line from the Aleutian Islands of Alaska, then along the northern border of Alaska and Canada, finally running through Greenland and Iceland. This line had 57 substations and six main stations. The extra warning time this line could provide justified the extra cost of building and maintaining radars in the extreme environment of the Arctic Circle.⁴¹ Figure 4 shows the DEW line as of 1954 and Figure 5 shows the completed DEW line.

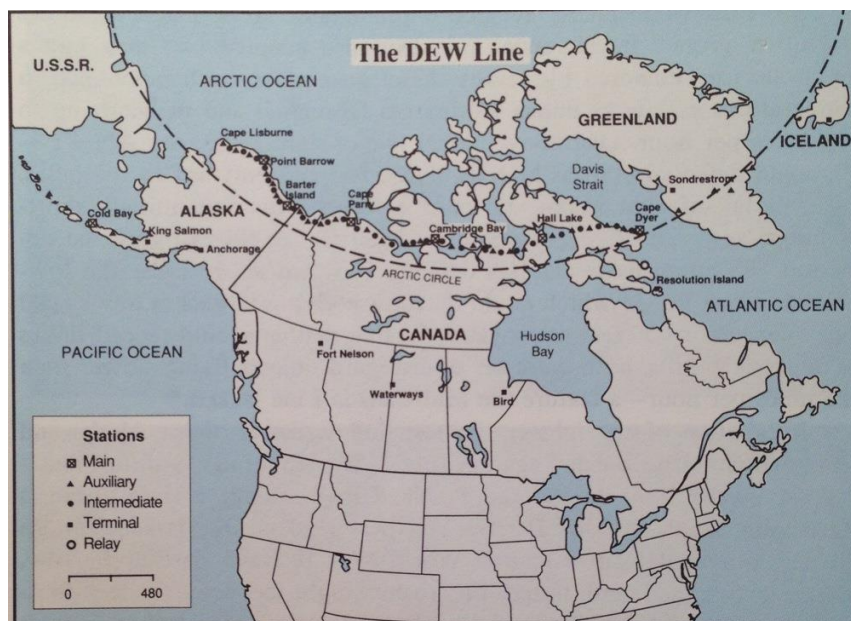


Figure 5: Completed DEW Line

Source: Schaffel, *The Emerging Shield*, 211.

Providing early warning coverage on the east and west coasts was a mixture of U.S. Navy picket ships, early warning airplanes, and Texas

⁴⁰ Schaffel, *The Emerging Shield*, 210. Grant, *USAF Historical Studies: No. 126*, 66. Calls the Mid-Canada Line a radar line.

⁴¹ Schaffel, *The Emerging Shield*, 211-215.

Towers (see Figure 6). These systems were expected to provide thirty minutes notice of a Soviet bomber attack. Texas Towers, radars on a platform bolted to the ocean floor, derived their name from their resemblance to oil rigs in the Gulf of Mexico. These three-sided platforms measuring 210 feet per side were located on a line starting 110 miles east of Cape Cod and ending 84 miles southeast of New York Harbor.⁴² The Air Force preferred these to the Navy picket ships, because the picket ships “were limited to carrying medium power radars and even when anchored were not stable platforms.”⁴³ Of the five planned Texas Towers, only three were built because the Air Force thought airborne early warning could do the job where Texas Towers one and five were to be installed.⁴⁴ The workhorse of airborne warning and control was the EC-121. The EC-121 had four radars to provide warning and control information. The EC-121 provided coverage on the east coast out of Otis Air Force Base, Massachusetts and west coast coverage out of McClellan Air Force Base, California.⁴⁵

⁴² Grant, USAF Historical Studies: No. 126, 73. Also in Schaffel, *The Emerging Shield*, 218-219.

⁴³ Grant, USAF Historical Studies: No. 126, 72.

⁴⁴ Schaffel, *The Emerging Shield*, 217.

⁴⁵ Schaffel, *The Emerging Shield*, 220.

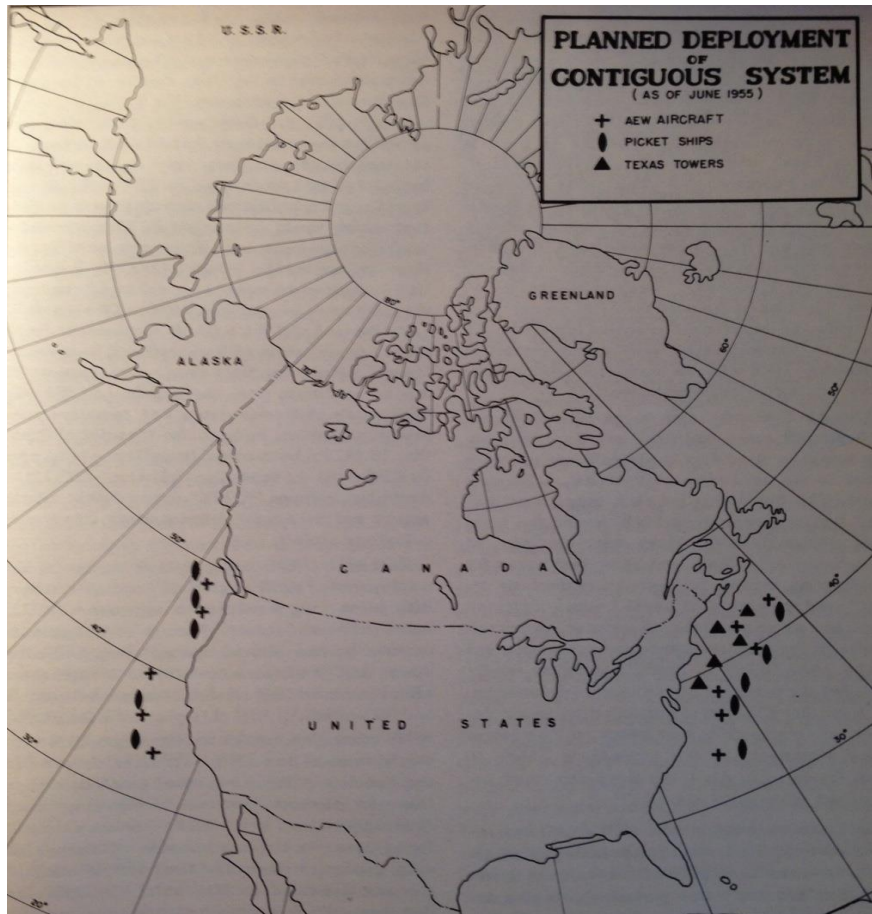


Figure 6: Seaward Extension of Radar Coverage

Source: Grant, USAF Historical Studies: No. 126, 69.

Technological limitations of radar left a low-altitude gap in the radar coverage of the United States borders. In 1950, the only means available to spot enemy aircraft approaching the United States from low-altitude was human observers. In February 1950, the Air Force submitted a plan calling for 160,000 volunteers to support some 8,000 observation posts. By June 1950, the program had the approval of the Secretary of Defense. One year later, the GOC had 210,000 volunteers supporting approximately 8,000 observation posts. However, reliability of the observation posts was low due to time required to get volunteers to their posts upon activation. Therefore, the Air Force proposed Operation SKYWATCH; 24-hour duty for 8,483 observations posts in 27 of the 36

states with GOC posts (see Figure 7). Operation SKYWATCH began on 17 May 1952 and continued until 24-hour duty was phased out in most observation posts on 1 January 1958. By mid-1953, the GOC had over 305,000 volunteers. On 31 January 1959 the Air Force deactivated GOC.⁴⁶

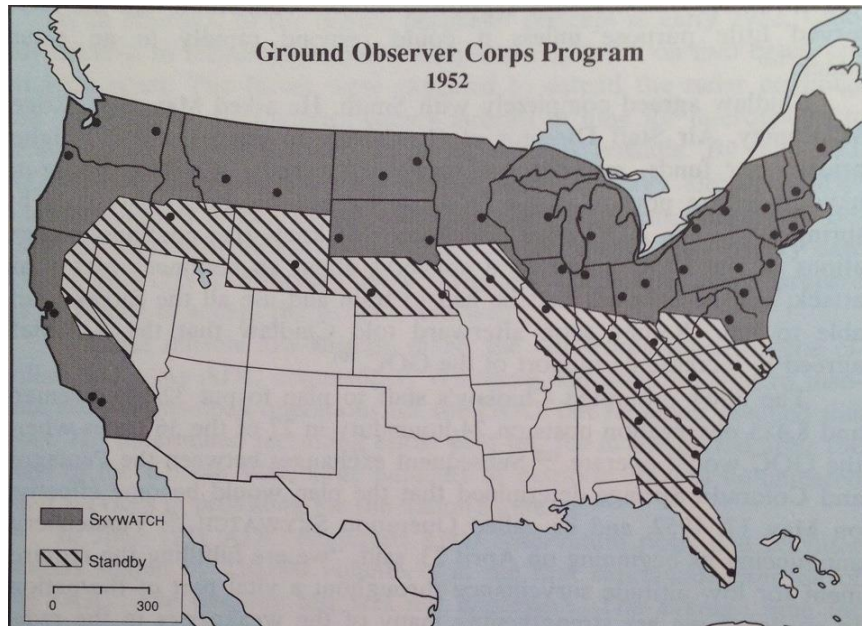


Figure 7: Ground Observer Corps Program 1952

Source: Schaffel, The Emerging Shield, 158.

The information provided by the sensors was then transferred to interceptors. Aircraft assigned the interceptor role as of September 1954 included the F-86D & F, F-94C, F-89C & D, and CF-100.⁴⁷ By December 1959 the primary interceptor aircraft were the F-89J, F-102A, F-104A, F-101B, and F-106A.⁴⁸ The preponderance of these aircraft were located on bases on the periphery of the country and two bases in Alaska (see Figure 8). Primary armament for interceptor aircraft up until late 1954 was machine guns. Then in late 1954, interceptors started carrying the

⁴⁶ Schaffel, *The Emerging Shield*, 120, 156, 159, 222.

⁴⁷ Grant, *USAF Historical Studies: No. 126*, 55. CF-100 information found at Bomber Command Museum, "CF-100," *Bomber Command Museum*, <http://www.bombercommandmuseum.ca/cf100.html> (accessed 31 March 2013).

⁴⁸ Schaffel, *The Emerging Shield*, 227.

“2.75-inch folding-fin air-to-air rockets (FFARs).”⁴⁹ Guided rockets followed in the form of the Hughes GAR-1 and GAR-2 Falcon and by 1957 interceptors were carrying the MB-1 Genie. The MB-1 was a nuclear tipped guided rocket.⁵⁰ U.S. Army antiaircraft artillery supplemented the Air Force’s airborne interceptors. Figure 9 shows the laydown of antiaircraft artillery as of 31 December 1953.

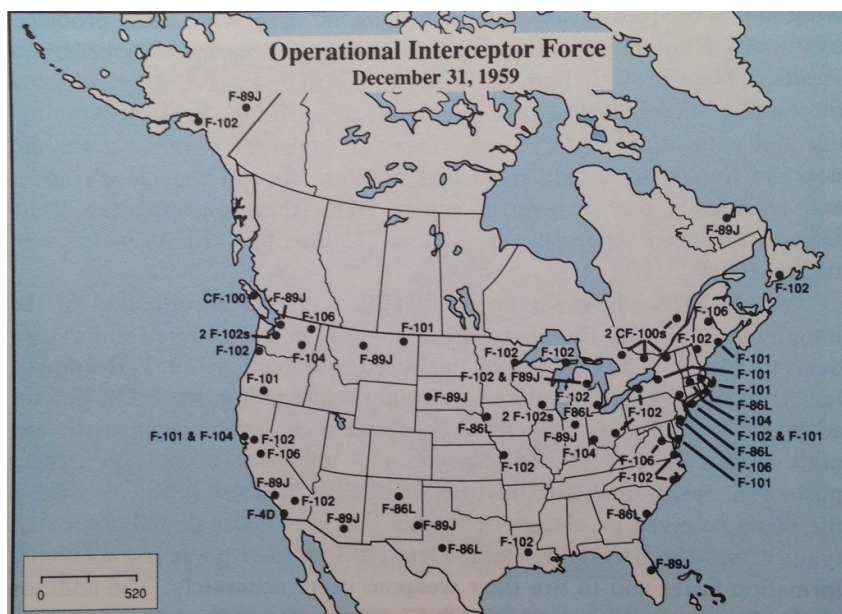


Figure 8: Operational Interceptor Force (31 December 1959)

Source: Schaffel, The Emerging Shield, 230.

Finishing out the defense in depth were U.S. Air Force BOMARC surface-to-air missiles and U.S. Army Nike surface-to-air missiles. Both of these missiles were designed to intercept enemy bombers. The Nike-1 variant was fielded first and in 1952 approved for 32 battalions in 14 geographic areas. The Air Force BOMARC was designed as a medium-range missile with a 200 nm range versus the Nike’s 25 nm range. It would have a higher maximum altitude than the Nike-1 (80,000’ vs.

⁴⁹ Schaffel, *The Emerging Shield*, 233.

⁵⁰ Schaffel, *The Emerging Shield*, 233-234. GAR-1 and GAR-2 were eventually renamed under the designation AIM-4. Directory of US Military Rockets and Missiles, “AIM-4,” *Directory of US Military Rockets and Missiles*, <http://www.designation-systems.net/dusrm/m-4.html> (accessed 31 March 2013).

60,000') and fly faster than the Nike-1 (3 mach vs. 0.9 mach).⁵¹ The BOMARC, however, did not achieve operational readiness until December 1959 and fielding was limited to fewer than 500 missiles assigned to only eight sites in northeastern United States and only two sites in Canada.⁵² In order to be effective, however, all of these systems required an effective command and control architecture.

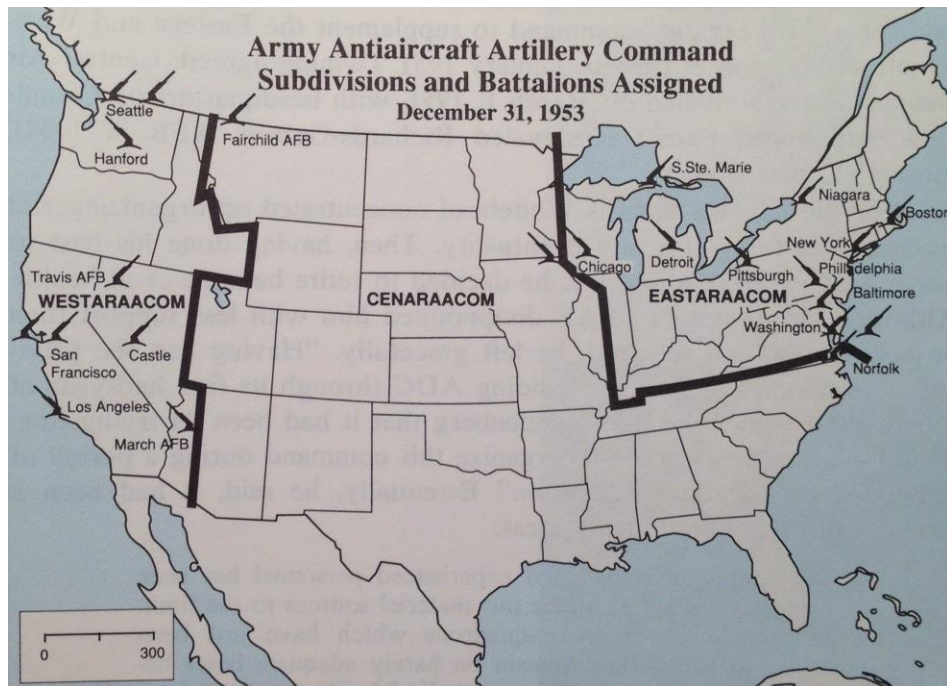


Figure 9: Army Antiaircraft Artillery 1953

Source: Schaffel, *The Emerging Shield*, 147.

What was the system for command and control?

The organization for control of air defense in North America was in constant change from the end of World War II until the late 1950s. Therefore, this section will address the organization and command and control that existed as the 1950s came to a close. Overseeing defense of North America was the North American Air Defense Command (NORAD)

⁵¹ Center of Military History, *History of Strategic Air and Ballistic Missile Defense Volume 1*, 107-108. For more information on the BOMARC missile see Boeing, "BOMARC Missile," Boeing, <http://www.boeing.com/boeing/history/boeing/bomarc.page> (accessed 31 March 2013).

⁵² Schaffel, *The Emerging Shield*, 236.

with an American in charge and a Canadian as the deputy. NORAD had operational control of the U.S. Army Air Defense Command, U.S. Naval Forces CONAD, Air Force Air Defense Command, and the Air Defense Command of Canada. The U.S. Army Air Defense Command provided antiaircraft artillery, U.S. Naval Forces CONAD provided the picket ships, and the Air Force Air Defense Command provided the radar lines and airborne interceptors. Training, equipping, and organizing the forces still fell under the control of the individual service commands.⁵³

Finally, tying together all these individuals, organizations, and equipment was the semi-automated ground environment (SAGE). SAGE was the first computer-controlled network to coordinate all aspects of the air defense network.⁵⁴ The task of SAGE was to aid the air defense system in performing its four primary functions: detection, identification, interception, and destruction.⁵⁵ The primary objective of this system was “to allow SAC sufficient warning for dispersing its bombers and launching retaliatory raids, not to shoot down enemy bombers.”⁵⁶ The secondary objective of the system was to shoot down as many enemy bombers as possible before they could hit their targets. In order to accomplish these objectives, the “DEW line would provide the initial detection of the hostile attack, the mid-Canada line would confirm the attack and order an interceptor scramble, and the Pinetree line and the permanent radars in the United States would direct the interception.”⁵⁷ In order to accomplish this sequence, SAGE divided “the continental United States into eight air defense regions with eight SAGE combat

⁵³ Schaffel, *The Emerging Shield*, 252.

⁵⁴ Schaffel, *The Emerging Shield*, 197. Also in Robert Frank Futrell, *Ideas, Concepts, Doctrine*, vol. 1, *Basic Thinking in the United States Air Force 1907-1960* (Maxwell Air Force Base, AL: Air University Press, 1989), 532. Also in Computer Museum, “SAGE Computer System,” *Computer Museum*, <http://www.computermuseum.li/Testpage/IBM-SAGE-computer.htm> (accessed 31 March 2013).

⁵⁵ Futrell, *Ideas, Concepts, Doctrine*, vol. 1, 528.

⁵⁶ Schaffel, *The Emerging Shield*, 239.

⁵⁷ Futrell, *Ideas, Concepts, Doctrine*, vol. 1, 532.

operations centers and 32 air defense sectors with 32 SAGE direction centers.”⁵⁸ This computer-controlled system provided the air defense system the ability to direct and keep track of hundreds of intercepts simultaneously.⁵⁹

What were the rules of engagement (ROE) for acting upon the threat?

An MIT study proposed the rules of engagement (ROE) for the soon to be built air defense system in 1951. The ROE was split into two parts. The first part dictates when an aircraft could be fired upon. This section applies to airborne and ground based interceptors:

At present no aircraft may be fired upon unless

1. It is manifestly hostile in intent, or
2. It commits an overt hostile act, or
3. It carries U.S.S.R. markings and appears without prior arrangement.⁶⁰

The second part of the ROE dictates the procedures to follow upon interception by an airborne interceptor. Airborne visual identification was the first priority of the air defense system.

1. The flight commander on obtaining a tallyho will report to the ground, stating what he has been able to ascertain about the nature of the aircraft.
2. The ground controller must then reply (within a short time, perhaps two minutes) whether or not the apprehension procedure is to continue.
3. Upon receipt of authorization from the ground, the flight then splits off a single fighter who proceeds to order the unknown

⁵⁸ Futrell, *Ideas, Concepts, Doctrine*, vol. 1, 532.

⁵⁹ Futrell, *Ideas, Concepts, Doctrine*, vol. 1, 532.

⁶⁰ Project Charles, *Massachusetts Institute of Technology Problems of Air Defense Final Report of Project Charles*, vol. 1 (Cambridge, MA: Massachusetts Institute of Technology, 1951), 17-18.

aircraft to land by maneuver, lowering of the landing gear, and the use of lights at night.

4. If no response to this maneuver is obtained, the detached aircraft will fire “across the bow” of the unknown aircraft.
5. If the unknown aircraft finally fails to respond and does not proceed to land, the balance of the flight of aircraft will open fire.⁶¹

What did this air defense system provide for future military capability?

Although the scope of the continental air defense problem is larger than the air defense of forward deployed U.S. forces, the technological and procedural challenges are the same. Defending forward operating bases still requires sensors to provide early warning, shooters to handle destruction of the threat, and a means of command and control. More significantly, the struggle to achieve these three elements in the 1950s in the United States provided the knowledge that has allowed the United States to project air power around the globe today. AWACS, originally developed in the 1950s, provides the air picture to air superiority fighters who get initial intercept handoffs via GCI procedures from air battle managers onboard AWACS. GCI procedures were also a product of figuring out the air defense problem in the 1950s.

The processes determined during the 1950s have proven success in US Air Force offensive operations across the globe well into the twenty-first century. However, from a purely defensive point of view, the system was never tested in actual combat operations while it was in place. Therefore, the only means by which to evaluate its effectiveness are the results of exercises accomplished during the system lifetime. One such exercise was Operation SKY SHIELD accomplished in September 1960.

⁶¹ Project Charles, Massachusetts Institute of Technology Problems of Air Defense, 17-18.

How did it work?

Operation SKY SHIELD was a joint SAC/NORAD exercise executed on 10 September 1960 with the purpose of testing the effectiveness of the continental air defense system. The Operations Order of Second Air Force defined the basic objective of SKY SHIELD:

To exercise all elements of the North American Defense System utilizing maximum airborne ECM and radar jamming against NORAD GCI sites, NIKE radars, AI, DEW Line, Mid Canada Line, Picket Ships, the Atlantic and Pacific Barriers, etc. Where possible, strikes would be made from beyond the radar periphery of the North American Continent utilizing both high and low altitude attacks in as realistic manner as peace time restrictions and flying safety considerations allow.⁶²

To accomplish this objective, "A SAC aggressor force of approximately 350 bombardment aircraft was to simulate an attack against the North American continent using maximum and continuous ECM, chaff, and communications jamming."⁶³ Furthermore, in order to provide a valid evaluation of the air defense system, the attacks "were designed to simulate those which the Soviets could be expected to employ should they make a manned bomber attack on the continent."⁶⁴ In other words, SAC planned to spread its force over a wide area, but still close enough to saturate the capability of the air defense system. This would involve near simultaneous high and low altitude air defense penetrations of the Pacific and Atlantic coastlines as well as northern Canada.⁶⁵ Second Air Force provided 99 of the 350 sorties and Fifteenth Air Force another 88 sorties.⁶⁶

⁶² History, HQ 2AF, Operations Order 11-61, SKY SHIELD, 27 July 60. Also in History, HQ NORAD, Operations Order 6-60, SKY SHIELD, 1 August 60.

⁶³ History, Second Air Force, Historical Data: July-December 1960 Volume I, 247.

⁶⁴ History, Second Air Force, Historical Data: July-December 1960 Volume I, 249.

⁶⁵ History, Second Air Force, Historical Data: July-December 1960 Volume I, 249-250.

⁶⁶ History, Second Air Force, Historical Data: July-December 1960 Volume I, 250.

History, Fifteenth Air Force, History of the Fifteenth Air Force: July through December 1960 Volume I, 69.

Results of the exercise as reported by the participating SAC units refer to whether scheduled sorties turned into actual sorties. However, further inspection provides some valuable insights. For example, Fifteenth Air Force stated, "Penetration by the [high] route was marginal to effective, but the low level approach was highly successful in escaping detection."⁶⁷ Included in the Fifteenth Air Force units participating in SKY SHIELD were the 92D Bombardment Wing with eight Boeing B-52s and the 4134th Strategic Wing with four B-52s.⁶⁸

The 92D Bombardment Wing's eight participating B-52s were split to provide four high altitude attacking aircraft and four low altitude attacking aircraft. All eight aircraft initiated the attack from well north of Alaska with 20-mile parallel tracks. The low aircraft maintained altitudes of 1,000 and 1,500 feet until over Alaska, at which point they climbed to 10,000 and 10,500 feet. Aircrew reported hearing the vectoring of defending interceptors on their recovery frequencies.⁶⁹ From this statement, it is safe to assume that some, if not all, of the aircraft would have been intercepted.

The 4134th Strategic Wing had much the same results as the 92D Bombardment Wing. All four of the 4134th participating B-52s were directed to begin their attack from low-altitude below the Aleutian Island chain and proceed into Alaska. After successfully striking their simulated targets in Alaska they would turn back south to egress back out over the water. Again, the bombers used 20-mile lateral separation and flew at an altitude approximately 1,500 feet above the highest land mass. According to the unit history, of the four participating B-52

⁶⁷ History, Fifteenth Air Force, History of the Fifteenth Air Force: July through December 1960 Volume I, 69.

⁶⁸ History, Fifteenth Air Force, History of the Fifteenth Air Force: July through December 1960 Volume I, 68.

⁶⁹ History, 92D Bombardment Wing, History 92D Bombardment Wing (Heavy) and 92D Combat Support Group: 1 through 30 September 1960, 29-31.

aircraft, only one met with success. The other three aircraft reported fighter activity.⁷⁰

Finally, one of the Second Air Force units participating in the exercise, 4245th Strategic Wing, met with a higher success rate. Unlike the other Wings, the 4245th was directed to attack the continent via the California coast. Again, the Wing flew four B-52s with 20-mile lateral separation.⁷¹ The unit history simply states, “the four aircraft, upon penetrating, hit [their] targets.”⁷² No information to conclude the aircraft were successfully intercepted by the defenses is found in the unit history.

Results depicted in the above unit histories show a mix of success and failures for NORAD. At first glance, the mix of success and failure in Operation SKY SHIELD leads to the conclusion that the air defense system of 1960 was a failure. After all, even one Soviet bomber with nuclear weapons successfully bombing its target would be devastating. However, defining success of the continental air defense system should reflect the objective of that system. Under the policy of mutually assured destruction, the ability to perform a retaliatory strike is paramount in the deterrence strategy. Therefore, the air defense system did not need to kill all inbound enemy bombers. It just needed to provide ample warning to SAC so that it could launch the retaliatory force. Of course, the more successful intercepts, the less damage done to American soil, but the primary focus was launching the Air Force bombers. Keeney, in *15 Minutes*, quotes an Air Defense Command statement in 1954, “...we believe that our primary mission in the Air Defense Command is to defend the bases from which Strategic Air Command is going to

⁷⁰ History, 4134th Strategic Wing, History of the 4134th Strategic Wing: 1 September 1960 – 30 September 1960, 18-19.

⁷¹ History, 4245th Strategic Wing, 1-30 September 1960, 15.

⁷² History, 4245th Strategic Wing, 1-30 September 1960, 15.

operate.”⁷³ Bernard Brodie, author of *Strategy in the Missile Age*, argues, “Whatever is done or not done to defend cities and populations... there is no question that very considerable passive as well as active defenses should be put around our retaliatory air force.”⁷⁴ Put in the light of these claims concerning air defense in the nuclear age, Operation SKY SHIELD was a success. The continental air defense system had successfully found, tracked, and intercepted approximately fifty percent of the three wing’s participating aircraft. Simply by detecting the raid, the air defense system would have notified SAC to launch its forces and the American retaliatory strike would have been on its way. The air defense system, it seems, was able to perform its role in the strategy of deterrence, and, the deterrence strategy successfully avoided direct conflict with the Soviet Union.

⁷³ Keeney, *15 Minutes*, 113.

⁷⁴ Bernard Brodie, *Strategy in the Missile Age* (1959; repr., Santa Monica, CA: RAND, 2007), 221.

Chapter 5

Evaluation: The case for a dedicated integrated air defense system in the United States

The purpose of this chapter is to compare the current threat environment of the United States to those found in this thesis' case studies. By accomplishing this comparison, this chapter attempts to answer three questions. What criteria triggered the construction of an integrated air defense system in the past? When those criteria are met, what should an integrated air defense system look like? Are those criteria present today? The answers to these questions are developed using the framework of the previous case studies. Finally, this chapter provides conclusions based on the responses to those questions.

Why should the United States build an integrated air defense system?

This question revolves around the idea that the United States has an enemy capable of threatening its citizens within the boundaries of US sovereign territory. In the case of Britain in the post-World War I era, the threat initially appeared to be the French air menace, which in turn drove the British rearmament plan. However, the French threat quickly evaporated due to a geo-political reversion to World War I alliances, and, within a decade, an overtly aggressive Germany rose as the chief threat. British military planners quickly transitioned the Royal Air Force organization and overall strategy to match the new German threat. This transition made possible the institution of the British air defense system.

The signposts leading to the US air defense system after World War II followed much the same pattern as Britain in the interwar years. The mutual distrust between the United States and the Soviet Union, the roots of which began at the Yalta Conference, combined with new technology to create a sense of vulnerability unparalleled in the history of the ocean cradled nation. The resulting competition between the United

States and the Soviet Union provided the motivation to build a continental integrated air defense system.

Therefore, if the United States needs a modern integrated air defense system today, there must first be a credible enemy. In response to US missile defense plans over the last decade, Russia began reinvigorating its military prowess in 2007 to include its long-range strike capability.¹ Since then, Russia has shown a reinvigoration of US ADIZ penetrations using long-range bombers and submarine patrols off the US coast. But is Russia signaling intent to attack the US homeland? Given the nuclear balance which still exists twenty years after the end of the Cold War, these moves are most likely posturing related to foreign policy moves and there is little risk of an actual US-Russia military conflict. As of 2013, despite high oil reserves, flat oil prices will keep the Russian military budget tight. Further, based on a weak global economy, high inflation, and sluggish domestic demand, the Russian government will most likely follow a moderate consolidation strategy through 2015. These factors combine to limit Russian external military policy while it concentrates on internal domestic policies.² So the Cold War threat of Russian nuclear attack, while theoretically still possible, is realistically unlikely.

Many in the US military community view China as the biggest threat to future US national security. However, China has not shown any direct intent of attacking the US. China has developed a significant ballistic missile capability, a direct threat to the US, but China has not developed a concurrent bomber capability. The most likely reason for US-China conflict concerns Taiwan. If a military conflict over Taiwan

¹ Luke Harding, "Russia Steps Up Military Expansion," *The Guardian*, 21 August 2007, <http://www.guardian.co.uk/world/2007/aug/22/topstories3.russia> (accessed 18 April 2013).

² Kaspar Richter, "Russian Economic Update – February 2013," *The World Bank*, 26 February 2013, <http://www.worldbank.org/en/news/feature/2012/10/08/russia-economic-update> (accessed 18 April 2013).

were to arise, military operations would probably stay in that region without direct Chinese attacks on the US mainland, given the nuclear deterrent each side possesses.

Besides Russia and China, there is Bush's "axis of evil." In 2002, then President George Bush, declared Iraq, Iran, and North Korea as the axis of evil.³ The US, as of the time of this writing, has concluded its intervention in Iraq, halting its progress toward developing a strike capability against the US and its allies. Tensions between the US and Iran continue to simmer as Iran appears to be developing nuclear weapons and North Korea recently completed its third nuclear detonation test. Iranian nuclear ballistic missiles or strike aircraft could threaten US interests in the Middle East and North Korean ballistic missiles or aircraft could threaten US interests in Asia, to include US Pacific territories. However, neither country possesses the capability to threaten the continental United States.

In sum, while Russia and China have the capability, their hostility towards the US has greatly diminished since the end of the Cold War, and while Iran and North Korea are clearly hostile, they don't yet have the capability. The chief concern, therefore, is non-state aggression. However, the tools available for a non-state actor attacking the US homeland do not lend themselves to defeat by an air defense system. Therefore, although the United States faces hostile nations throughout the world, there is no direct threat to US continental national security that requires a change in the current United States air defense posture.

What is the perceived threat?

Is there a new threat today that has the potential to affect national security as the airplane did to Britain and the combination of long-range aircraft and nuclear weapons did to the United States? One theory holds

³ Glenn Kessler and Peter Baker, "Bush's 'Axis of Evil' Comes Back to Haunt United States," *Washington Post*, 10 October 2006, <http://www.washingtonpost.com/wp-dyn/content/article/2006/10/09/AR2006100901130.html> (accessed 18 April 2013).

that the cruise missile is that weapon. However, the cruise missile has been around since the German V-1 in World War II.⁴ Capability of the cruise missile has come a long way since the V-1. Cruise missiles today can be stealthy, cover long distances, and carry large payloads, but do these characteristics make it a new weapon that should change the way America views its potential impact on national security?

Perhaps, the advanced technology and wide proliferation of cruise missiles today, due to lower costs, increases the threat it poses to the United States. Joint Publication 3-01 states, “Proliferation of advanced technologies for missiles, guidance systems, and weapons of mass destruction warheads has increased the potential missile threat to the homeland.”⁵ In 2008, a RAND monograph stated, “Cruise missiles are at times dubbed ‘the poor man’s air force’: In some circumstances, they can achieve similar effects to that of fixed-winged aircraft for a fraction of the cost. And, although perhaps not as illustrious as ballistic missiles, cruise missiles carry a certain status for countries and militaries as a milestone in weapon prowess and technical advancement.”⁶ Given this, do a small number of cruise missiles in non-state actor’s hands, or in the hands of North Korea or Iran, justify the expense of a countrywide integrated air defense system? The answer is most likely no. This answer is more credible given the amount of public perception concerning the most likely threats facing America today.

What is public opinion concerning the perceived threat?

Although the potential of a cruise missile threat has found its way into Congressional hearings in the last decade, news headlines and

⁴ David S. Sorenson, “Defending Against the Advanced Cruise Missile: The Ultimate Air Defense Nightmare?,” in *Strategic Air Defense*, ed. Stephen J. Cimbala (Wilmington, DE: Scholarly Resources Inc., 1989), 141.

⁵ Joint Publication (JP) 3-01, *Countering Air and Missile Threats*, 23 March 2012, x.

⁶ Brian A. Jackson, David R. Frelinger, Michael J. Lostumbo, Robert W. Button, *Evaluating Novel Threats to the Homeland: Unmanned Aerial Vehicles and Cruise Missiles* (Santa Monica, CA: RAND, 2008), xiii.

popular media such as books and movies do not reflect a public concern for cruise missile attacks.⁷ In fact, the most popular attack vector on the United States in the mass media today is cyberspace. For example, President Obama's most recent State of the Union address made no mention of any air-breathing threat to the US, but it did mention cyberspace vulnerabilities and the need for the US to "strengthen our cyber defenses by increasing information-sharing and developing standards to protect our national security, our jobs, and our privacy."⁸ Along with threats to United States cyberspace, the only other external threats to the United States mentioned by President Obama were the continued concern over eradication of terrorism and a continued emphasis on strengthening the ballistic missile defenses of the United States.

A lack of public opinion concerning an air threat does not automatically signify that a threat does not exist, just as a strong public opinion concerning a threat does not automatically signify that attack is imminent. British public perception of the threat posed by the airplane gained a wide following in the early 1900s, yet attack from the air did not cause significant disruption and destruction in Britain until World War II. American public perception of the threat posed by the combination of long-range aircraft and nuclear weapons did not emerge until after the Soviet Union developed the capability even though the United States had already shown the destructive nature of the combination almost four years previously. Nevertheless, in a democracy, whether public opinion is intuitive or reactionary, it provides a litmus test concerning the

⁷ Ravi R. Hichkad and Christopher Bolkcom, *Cruise Missile Defense*, Report for Congress (Washington, DC: Congressional Research Service, 2005), 1-6.

⁸ Barrack Obama, "State of the Union Address 2013," *Washington Post*, 12 February 2013, http://articles.washingtonpost.com/2013-02-12/politics/37059380_1_applause-task-free-enterprise/7 (accessed 6 March 2013).

potency of the threat, especially once the threat exists in the wild for a couple years.

Pre-9/11, public opinion did not reflect any threat to the continental United States. Following 9/11, public opinion reflected the terrorist threat, and so the US government drastically reorganized to combat the perceived threat. The reorganization included the Department of Homeland Security, bolstering US Customs and Border Protection, and reinvigorating air defense of the homeland. All of these steps were taken to prevent a recurrence of a Pearl Harbor-type attack. Today, reflecting on President Obama's 2013 State of the Union address, American mainstream media does not perceive a cruise missile threat, recognizes a potential ballistic missile threat, highlights a cyber threat, and pushes the terrorist threat at a much reduced level.

What systems/technology should the United States put in place to detect and act upon that threat?

An integrated air defense system includes the systems/technology put in place to detect and act upon a threat, a streamlined command and control, and rules of engagement (ROE) for acting upon the threat. This statement does not mean that every integrated air defense system is the same or that it does not evolve to fulfill unique demands for the given threat. On the contrary, these universal elements provide broad categories for the unique requirements of all integrated air defense systems, but the individual elements themselves may appear quite different from system to system when fully developed to meet the given threat.

Radar, for example, was the primary means for detecting the threat in both the British World War II and United States Cold War air defense systems. However, the capability and positioning of radar in both cases was distinctly different. British radar had difficulty determining the size of a raid. It was also located on the English coast providing just enough time to launch aircraft and attempt initial intercept over the English

Channel before German raiders entered British airspace. US radar, on the other hand, was more advanced and provided more fidelity concerning the number of aircraft approaching. Furthermore, much of the US radar was located in northern Canada in order to provide greater detection time and take into account the higher speeds of the aircraft of the time.

Future early warning may not actually be provided by radar, as it is known today. For example, in attempting to negate the effects of stealth, reduced radar signature, technology on modern radar, the Chinese and Russians have been developing VHF and UHF 'radars.' Czech researchers have also devised a passive detection system utilizing television and cellular signals to track the disturbance in the data streams made by stealth aircraft.⁹ In other words, early warning for any future air defense system must be suited to detect this new threat. Finally, just as the early warning portion of any air defense system must be tailored to meet the threat, so, too, must the other systems/technology to detect and act upon the threat, command and control, and ROE.

At the heart of the problem to tailor all three elements to the threat is the need to provide enough time between detection and an appropriate response, resulting in threat negation by reducing the ability of the threat to complete its attack. This time must provide for detection, decision to intercept, time to complete an intercept, and time to make a decision concerning the appropriate response. Therefore, creation of systems and structures for the early warning and tracking, command and control, and ROE must be uniquely developed to defeat the threat.

⁹ David Axe, "China, Russia Could Make U.S. Stealth Tech Obsolete," *Wired*, 7 June 2011, <http://www.wired.com/dangerroom/2011/06/stealth-tech-obsolete/> (accessed 6 March 2013).

What would be the system for command and control?

Although the command and control must be uniquely suited for the specified threat, there are certain necessary conditions it must fulfill. It must have an efficient method of taking the early warning information and passing it up to a decision-making authority. The decision-making authority must be able to efficiently assign the inbound track to an appropriate response option in accordance with ROE. In some cases, the response option may be surface-to-air missiles or anti-aircraft artillery. In other cases, the required response may be to launch intercept aircraft. Regardless of the response chosen, the command and control system must be able to provide the bearing, range, altitude, and speed associated with the inbound track to the response force. Finally, the responding force must have the ability, within prescribed ROE, to act against the inbound track. The range of actions must be prescribed within ROE and the decision to execute the range of actions must rest with the responding force. This principle of centralized control and decentralized execution is paramount to any command and control system as it provides the shortest timeline from detection to action and gives the final action decision to the individuals most aware of the intricacies of the situation at its source.

What would be the rules of engagement (ROE) for acting upon the threat?

Historically, ROE stipulates positive visual identification of the threat prior to making a decision on the appropriate response. Regardless of what the responding force, the actions at their disposal must be prescribed and known ahead of time. Visual identification provides the best option of minimizing collateral damage. However, the timeline associated with providing visual identification requires warning early enough to complete the detect, launch interceptor aircraft, complete the intercept, visually identify, decide on the appropriate response, and complete the response action timeline. This timeline, based on the speed

of the incoming threat, then determines the location of the early warning system.

Conclusion

The study of the British integrated air defense system built in the interwar years and the United States integrated air defense system built immediately after World War II yields criteria that appear to provide an adequate gauge for determining the need to build a new integrated air defense system. The first criteria is a new threat. A new threat does not necessarily need to be an unknown weapon. It can be a variation on an existing weapon. For example, the threat to the United States was a variation of the airplane carrying an atomic bomb. The second criteria is an actor willing to threaten the national security of a fellow nation with the new threat. Finally, public perception of the threat and actor combination provides a good measure of the true vulnerability to national security. High public perception signifies a high vulnerability to the perceived threat, while low public perception signifies a low vulnerability to the perceived threat. Although these criteria for building an air defense system do not appear to be present today, they provide a means of determining when the current capabilities of the United States no longer meet the needs of United States' national security.

The United States has the capability to defend itself from the most likely threats that exist today. These capabilities have been developed over the last two decades, primarily in response to the need to defend American troops located abroad. The NCR-IADS reflects those capabilities. If the need arose to increase defense of the United States against an existing threat, adequate technology exists and would only need to be expanded into larger numbers. This is important because it is always quicker to field existing technology than wait until the need arises to not only invent the equipment, but also field it in quantities large enough to make a difference.

In the future, the United States should continue to research and develop technology capable of defending against any evolving threat. This works for several reasons. First, continuing to develop this technology allows the United States to provide the best air defense available for troops stationed abroad. Second, continuing to develop the technology allows the United States to expand its embryonic capability via implementation of a modern integrated air defense system across as much of the country as is deemed appropriate whenever the need arises. By keeping abreast of the latest technological developments, the US will reduce the time lag associated with research and development. By not deploying a large system, costs can be reduced until the threat requires building and fielding equipment in quantities large enough to answer the threat. For example, the perception of the French Air Menace in the 1920s forced Britain to assess its air defense capabilities and act on its weaknesses. The perception of the French air threat forced Britain to take measures in terms of development and planning that put it in a position to implement a wider-scale air defense system when the threat changed from France to Germany and war ensued. Without the development and planning spawned by the French Air Menace, the time bought at Munich might not have been enough for Britain to develop, plan, and execute the air defense system that allowed its survival during the Battle of Britain. Likewise, after World War II, as the US drastically downsized its military, the lessons learned about air defense in World War II were crucial in facilitating the development and deployment of a continental air defense system in the Cold War.

Furthermore, the resource-constrained environment the US finds itself in today may limit its ability to continue research and development. In the interwar years the British similarly found themselves in a severe budget crisis. What funds were available were committed to supporting the offensive strategy of the knockout blow. As a result, the air defense

received few resources. This did not mean Britain ignored air defense, rather they focused on what they could afford—thinking about detection and the integration of the air defense system. The aircraft came later as the threat grew and priorities shifted towards the defense. In the 21st century the key to success is still the ability to detect the enemy and to coordinate the defense before the enemy can complete an attack.

Therefore, along with research and development, the US must continue to plan how it will detect and coordinate the defense against the evolving threat. The implicit argument here also means that the US must continue to think about the form the evolving threat might take in order to determine the best way to detect that threat and coordinate a relevant defense.

Part of coordinating a defense against a threat is determining the best way to concentrate forces against an inbound threat. In the interwar years, Dowding of Fighter Command realized there was no way to defend the entirety of Britain from air attack. Instead, Fighter Command had to determine the vital military and civilian targets in Britain and design the defense around those targets. The US similarly had to prioritize the defense of military and civilian targets at the beginning of the Cold War. In both cases, the military and civilian targets that received the priority were those that maximized the ability of the US and Britain to maintain the capability and the will to engage the enemy in the event of attack. Dowding's system accepted attacks on airfields and optimized the defense by creating a system of dispersed airfields. However, attacks on London were not tolerated to the same degree and fighter responses to attacks on London were organized to maintain constant pressure on the attacking German aircraft. The US system provided for defense of major population centers but did not provide defense for lesser population centers. Contrary to the British system, however, the US system provided higher defenses for airfields as

the ability to launch US bombers underpinned the offensive strategy of nuclear deterrence. Similarly, the US today should plan where to optimize defensive systems to combat the evolving threat without having to defend the entire country.

Although it appears there are no vital air threats to the continental United States today, the US must not mothball or shut down its current air defenses and must continue to research, develop, and plan the capabilities to defend against the threats of today in order to be able to execute tomorrow because the cost of failure when the moment arises is unacceptable.

Bibliography

Articles

- Air Miles Calculator. "Distance from Sokol Airport (GDX) to Seattle Tacoma International Airport (SEA)." *Air Miles Calculator*.
<http://www.airmilescalculator.com/distance/gdx-to-sea/> (accessed 27 March 2013).
- Alsop, Joseph and Stewart. "We Accuse!" *Harper's Magazine*, 1 October 1954: 25-45.
- Axe, David. "China, Russia Could Make U.S. Stealth Tech Obsolete." *Wired*. 7 June 2011.
<http://www.wired.com/dangerroom/2011/06/stealth-tech-obsolete/> (accessed 6 March 2013).
- Boeing. "Avenger Derivatives: Adaptive Force Protection Solutions." *Boeing*. 1 March 2012. http://www.boeing.com/defense-space/space/avenger/docs/Avenger_overview.pdf (accessed 2 January 2013).
- . "BOMARC Missile." *Boeing*.
<http://www.boeing.com/boeing/history/boeing/bomarc.page> (accessed 31 March 2013).
- . "History: B-29 Superfortress." *Boeing*.
<http://www.boeing.com/boeing/history/boeing/b29.page> (accessed 27 March 2013).
- Bomber Command Museum. "CF-100." *Bomber Command Museum*.
<http://www.bombercommandmuseum.ca/cf100.html> (accessed 31 March 2013).
- Computer Museum. "SAGE Computer System." *Computer Museum*.
<http://www.computermuseum.li/Testpage/IBM-SAGE-computer.htm> (accessed 31 March 2013).
- CONR-1AF (AFNORTH). "CONR Achieves 55,000th Noble Eagle Sortie." *1st Air Force*. 14 January 2010.
<http://www.1af.acc.af.mil/news/story.asp?id=123185605> (accessed 2 January 2013).
- Directory of US Military Rockets and Missiles. "AIM-4." *Directory of US Military Rockets and Missiles*. <http://www.designation-systems.net/dusrm/m-4.html> (accessed 31 March 2013).
- Ferris, John. "Fighter Defence Before Fighter Command: The Rise of Strategic Air Defence in Great Britain, 1917-1934." *The Journal of Military History* 63, no. 4 (October 1999): 845-884.

- Ferris, John. "The Theory of a 'French Air Menace', Anglo-French Relations and the British Home Defence Air Force Programmes of 1921-25." *Journal of Strategic Studies* 10, no. 1 (1987): 62-83.
- Gertz, Bill. "Russian Bombers Over Guam." *Fox News*. 19 February 2013. <http://nation.foxnews.com/russia/2013/02/19/russian-bombers-over-guam> (accessed 21 March 2013).
- Harding, Luke. "Russia Steps Up Military Expansion." *The Guardian*. 21 August 2007. <http://www.guardian.co.uk/world/2007/aug/22/topstories3.russia> (accessed 18 April 2013).
- History Learning Site. "Germany and Rearmament." *History Learning Site*. http://www.historylearningsite.co.uk/germany_and_rearmament.htm (accessed 23 March 2013).
- Hsu, Spencer S., and John Mintz. "Military was Set to Down Cessna." *Washington Post*. 25 May 2005. <http://www.washingtonpost.com/wp-dyn/content/article/2005/05/24/AR2005052400408.html> (accessed 21 March 2013).
- IMDB. "Dr. Strangelove or: How I Learned to Stop Worrying and Love the Bomb." *IMDB*. <http://www.imdb.com/title/tt0057012/> (accessed 22 January 2013).
- Kessler, Glenn, and Peter Baker. "Bush's 'Axis of Evil' Comes Back to Haunt United States." *Washington Post*. 10 October 2006. <http://www.washingtonpost.com/wp-dyn/content/article/2006/10/09/AR2006100901130.html> (accessed 18 April 2013).
- Kirby, M., and R. Capey. "The Air Defence of Great Britain, 1920-1940: An Operational Research Perspective." *The Journal of the Operational Research Society* 48, no. 6 (June 1997): 555-568.
- Kreisher, Otto. "The Years of Noble Eagle." *Air Force Magazine*. 1 June 2007. <http://www.airforce-magazine.com/MagazineArchive/Pages/2007/June%202007/0607eagle.aspx> (accessed 31 December 2012).
- Lockheed Martin. "PAC-3 Missile." *Lockheed Martin*. <http://www.lockheedmartin.com/us/products/PAC-3.html> (accessed 2 January 2013).
- Missile Defense Agency. "Missile Defense Agency Fact Sheet: Ballistic Missile Defense Intercept Flight Test Record." *Missile Defense Agency*.

- 26 October 2012.
<http://www.mda.mil/global/documents/pdf/testrecord.pdf>
 (accessed 2 January 2013).
- . “Our Mission.” *Missile Defense Agency*.
<http://www.mda.mil/about/mission.html> (accessed 2 January 2013).
 - . “The Ballistic Missile Defense System (BMDS).” *Missile Defense Agency*. <http://www.mda.mil/system/system.html> (accessed 2 January 2013).
- Missile Threat. “Patriot.” *Missile Threat*. 23 April 2013.
<http://missilethreat.com/defense-systems/patriot/> (accessed 24 April 2013).
- National Museum of the US Air Force. “Soviet Union Impounds and Copies B-29.” *National Museum of the US Air Force*. 4 December 2006.
<http://www.nationalmuseum.af.mil/factsheets/factsheet.asp?id=185>
 2 (accessed 21 January 2013).
- Office of the Historian. “MILESTONES: 1937-1945, The Potsdam Conference, 1945.” *US Department of State*.
<http://history.state.gov/milestones/1937-1945/PotsdamConf>
 (accessed 19 January 2013).
- . “MILESTONES: 1937-1945, The Tehran Conference, 1943.” *US Department of State*. <http://history.state.gov/milestones/1937-1945/TehranConf> (accessed 19 January 2013).
 - . “MILESTONES: 1937-1945, The Yalta Conference, 1945.” *US Department of State*. <http://history.state.gov/milestones/1937-1945/YaltaConf> (accessed 27 March 2013).
 - . “MILESTONES: 1937-1945, U.S.-Soviet Alliance, 1941-1945.” *US Department of State*. <http://history.state.gov/milestones/1937-1945/USSoviet> (accessed 19 January 2013).
 - . “MILESTONES: 1937-1945, Wartime Conferences, 1941-1945.” *US Department of State*. <http://history.state.gov/milestones/1937-1945/WarTimeConferences> (accessed 19 January 2013).
- Peralta, Eyder. “100 Years Ago, World's First Aerial Bomb Dropped Over Libya.” *NPR*. 21 March 2011. <http://www.npr.org/blogs/thetwo-way/2011/03/21/134735395/100-years-ago-the-first-aerial-bomb-fell-over-libya> (accessed 17 February 2013).
- Pike, John. “FIM-92A Stinger Weapons System: RMP & Basic.” *Federation of American Scientists*. 9 August 2000.

- <http://www.fas.org/man/dod-101/sys/land/stinger.htm> (accessed 22 March 2013).
- Richter, Kaspar. "Russian Economic Update - February 2013." *World Bank*. 26 February 2013.
<http://www.worldbank.org/en/news/feature/2012/10/08/russia-economic-update> (accessed 18 April 2013).
- Smith, Mike. "Guard Air Defense Units Protect Nation's Capital." *Global Security*. 22 April 2010.
<http://www.globalsecurity.org/security/library/news/2010/04/sec-100422-arnews01.htm> (accessed 31 December 2012).
- The National Archives. "Spotlights on History: Air Raids." *The National Archives*.
<http://www.nationalarchives.gov.uk/pathways/firstworldwar/spotlights/airraids.htm> (accessed 22 February 2013).
- The Washington Times. "Errant Cessna Cues White House Lockdown." *The Washington Times*. 25 April 2009.
<http://www.washingtontimes.com/news/2009/apr/25/errant-cessna-cues-white-house-lockdown/?page=all> (accessed 21 March 2013).
- Tilford, Robert. "Russia Set to Increase Submarine Patrols to Counteract US Threat." *The Examiner*. 25 February 2012.
<http://www.examiner.com/article/russia-set-to-increase-submarine-patrols-to-counteract-us-threat> (accessed 24 October 2012).
- Time. "Armed Forces: The New Dimension." *Time*, 8 February 1954: 18-25.
- . "Atomic ABCs." *Time*, 21 August 1950: 16-17.
- . "The U.S. Air Force: The Nation's Youngest Service Has Entered the Supersonic Age." *Time*, 5 March 1956: 56-65.
- U.S. Northern Command. "About USNORTHCOM." *U.S. Northern Command*. <http://www.northcom.mil/About/index.html> (accessed 1 January 2013).
- Young, Neil. "British Home Air Defence Planning in the 1920s." *Journal of Strategic Studies* 11, no. 4 (1988): 492-508.
- Zimmerman, David. "Information and the Air Defence Revolution, 1917-1940." *Journal of Strategic Studies* 27, no. 2 (2004): 370-394.

Books

- Beevor, Antony. *The Battle for Spain: The Spanish Civil War 1936-1939*. New York, NY: Penguin Group, 1982.

- Brodie, Bernard. *Strategy in the Missile Age*. Santa Monica, CA: RAND, 2007.
- Bungay, Stephen. *The Most Dangerous Enemy: A History of the Battle of Britain*. London, England: Aurum Press, 2000.
- Byrnes, James F. "Yalta: High Tide of Big Three Unity." In *The Yalta Conference*, edited by Richard F. Fenno Jr., 27-43. Lexington, MA: D. C. Heath and Company, 1972.
- Call, Steve. *Selling Air Power: Military Aviation and American Popular Culture after World War II*. College Station, TX: Texas A&M University Press, 2009.
- Center of Military History. *History of Strategic Air and Ballistic Missile Defense: 1945-1955*. Vol. 1. Washington, DC: United States Army, 2009.
- . *History of Strategic Air and Ballistic Missile Defense: 1956-1972*. Vol. 2. Washington, DC: United States Army, 2009.
- Churchill, Winston S. *The Gathering Storm*. Boston, MA: Houghton Mifflin Company, 1948.
- . *Triumph and Tragedy*. New York, NY: Houghton Mifflin Company, 1953.
- Craig, Campbell. *Destroying the Village: Eisenhower and Thermonuclear War*. New York, NY: Columbia University Press, 1998.
- Deighton, Len. *Battle of Britain*. London, England: George Rainbird Limited, 1980.
- Douhet, Giulio. *The Command of the Air*. Edited by Joseph Patrick Harahan and Richard H. Kohn. Tuscaloosa, AL: The University of Alabama Press, 2009.
- Edward R. Stettinius, Jr. *Roosevelt and the Russians: The Yalta Conference*. Garden City, NY: Doubleday & Company, Inc., 1949.
- Fuller, J. F. C. *The Reformation of War*. London, England: Hutchinson, 1923.
- Futrell, Robert Frank. *Ideas, Concepts, Doctrine: Basic Thinking in the United States Air Force 1907-1960*. Vol. 1. Maxwell Air Force Base, AL: Air University Press, 1989.
- Hardesty, Von, and Ilya Grinberg. *Red Phoenix Rising: The Soviet Air Force in World War II*. Lawrence, KS: University Press of Kansas, 2012.
- Harriman, W. Averell. "Statement Regarding Our Wartime Relations with the U.S.S.R., Particularly Concerning the Yalta Agreement." In *The*

- Yalta Conference*, edited by Richard F. Fenno Jr., 113-118.
Lexington, MA: Heath and Company, 1972.
- Higham, Robert. *Two Roads to War: The French and British Air Arms From Versailles to Dunkirk*. Annapolis, MD: Naval Institute Press, 2012.
- Holland, James. *The Battle of Britain: Five Months that Changed History May - October 1940*. London, England: Transworld Publishers, 2010.
- Jackson, Brian A., David R. Frelinger, Michael J. Lostumbo, and Robert W. Button. *Evaluating Novel Threats to the Homeland: Unmanned Aerial Vehicles and Cruise Missiles*. Santa Monica, CA: RAND, 2008.
- Jones, Priscilla D. *The First 109 Minutes: 9/11 and the U.S. Air Force*. Washington, DC: Air Force History and Museums Program, 2011.
- Keeney, L. Douglas. *15 Minutes: General Curtis LeMay and the Countdown to Nuclear Annihilation*. New York, NY: St. Martin's Press, 2011.
- McDonough, Frank. *Neville Chamberlain, Appeasement and the British Road to war*. New York, NY: Manchester University Press, 1998.
- McKercher, B. K. C. *The Foreign Office, 1930-39: Strategy, Permanent Interests and National Security*. Edited by Gaynor Johnson. New York, NY: Routledge, 2005.
- Miller, Roger G. *To Save a City: The Berlin Airlift, 1948-1949*. College Station, TX: Texas A&M University Press, 2000.
- Mitchell, William "Billy". *Winged Defense*. Tuscaloosa, AL: The University of Alabama Press, 2009.
- Mosley, Leonard. *Battle of Britain*. Edited by Time Life Books. Alexandria, VA: Time Life Books, 1977.
- Munson, Kenneth. *German Aircraft of World War 2*. Poole, Dorset: Blandford Press Ltd, 1978.
- Norris, Geoffrey. *The Royal Flying Corps: A History*. London, England: Frederick Muller Limited, 1965.
- Orange, Vincent. *Dowding of Fighter Command: Victor of the Battle of Britain*. London, England: Grub Street Publishing, 2008.
- Robertson, Scot. *The Development of RAF Strategic Bombing Doctrine, 1919-1939*. Westport, CT: Greenwood Publishing Group, 1995.
- Schaffel, Kenneth. *The Emerging Shield: The Air Force and the Evolution of Continental Air Defense 1945-1960*. Washington, DC: Office of Air Force History, 1991.
- Sheehan, Neil. *A Fiery Peace in a Cold War: Bernard Schriever and the Ultimate Weapon*. New York, NY: Vintage Books, 2009.

- Sherry, Michael S. *The Rise of American Air Power: The Creation of Armageddon*. New Haven, CT: Yale University Press, 1987.
- Smith, Malcolm. *British Air Strategy Between the Wars*. New York, NY: Oxford University Press, 1984.
- Sorenson, David S. "Defending Against the Advanced Cruise Missile: The Ultimate Air Defense Nightmare?" In *Strategic Air Defense*, edited by Stephen J. Cimbala, 139-160. Wilmington, DE: Scholarly Resources Inc., 1989.
- Spencer, Lynn. *Touching History: The Untold Story of the Drama That Unfolded in the Skies over America on 9/11*. New York, NY: Free Press, 2008.
- Stradling, Robert. *Your Children Will Be Next: Bombing and Propaganda in the Spanish Civil War 1936-1939*. Brigantine Place, Cardiff: University of Wales Press, 2008.
- The Yalta Conference. "The Crimea (Yalta) Conference: Documents: Protocol of Proceedings, February 11, 1945." In *The Yalta Conference*, edited by Richard F. Fenno Jr., 46-54. Lexington, MA: D. C. Heath and Company, 1972.
- Turner, John Frayn. *British Aircraft of World War II*. Briarcliff Manor, NY: Stein and Day, 1975.
- Wark, Wesley K. *The Ultimate Enemy: British Intelligence and Nazi Germany 1933-1939*. Ithaca, NY: Cornell University Press, 1985.
- Wells, H. G. *The War in the Air*. Edited by Patrick Parrinder. New York, NY: Penguin Classics, 2005.
- Werrell, Kenneth P. *Archie to SAM: A Short Operational History of Ground-Based Air Defense*. Maxwell AFB, AL: Air University Press, 2005.
- Whitty, H. Ramsden. *Observers' Tale: The Story of Group 17 of the R.O.C.* London, England: Roland Brothers, 1950.
- Winslow, T. E. *Forewarned is Forearmed: A History of the Royal Observer Corps*. London, England: William Hodge & Company, Limited, 1948.
- Yanarella, Ernest J. *The Missile Defense Controversy: Technology in Search of a Mission*. Lexington, KY: The University Press of Kentucky, 2002.

Government Documents

- Joint Publication (JP) 3-01. *Countering Air and Missile Threats*, 23 March 2012.
- Joint Publication (JP) 3-27. *Homeland Defense*. 12 July 2007.

Reports

- Grant, C. L. *USAF Historical Studies: No. 126, The Development of Continental Air Defense to 1 September 1954*. Maxwell AFB, AL: Research Studies Institute, Air University, 1957.
- Hickad, Ravi R., and Christopher Bolkcom. *Cruise Missile Defense*. Report for Congress, Washington, DC: Congressional Research Service, 2005.
- History. 4134th Strategic Wing, History of the 4134th Strategic Wing: 1 September 1960 - 30 September 1960.
- . 4245th Strategic Wing, 1-30 September 1960.
- . 92D Bombardment Wing, History 92D Bombardment Wing (Heavy) and 92D Combat Support Group: 1 through 30 September 1960.
- . Fifteenth Air Force, History of the Fifteenth Air Force: July through December 1960 Volume 1.
- . HQ 2AF, Operations Order 11-61, SKY SHIELD. 27 July 1960.
- . HQ NORAD, Operations Order 6-60, SKY SHIELD. 1 August 1960.
- . Second Air Force, Historical Data: July-December 1960 Volume 1.
- Project Charles. *Massachusetts Institute of Technology Problems of Air Defense Final Report of Project Charles*. Vol. 1. 3 vols. Cambridge, MA: Massachusetts Institute of Technology, 1951.

Speeches

- Obama, Barack. "State of the Union Address 2013." *Washington Post*. 12 February 2013. http://articles.washingtonpost.com/2013-02-12/politics/37059380_1_applause-task-free-enterprise/7 (accessed 6 March 2013).